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JEJUNAL ULCER

SOME OBSERVATIONS ON ITS COMPLICATIONS AND THEIR TREATMENT

By D. P. D. WILKIE, M.Ch., F.R.C.S.

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THE problem of jejunal ulcer is one of real, if somewhat melancholy, interest to the surgeon. It is one of his own producing and is admittedly difficult of solution. The operation of gastrojejunostomy, at one time regarded as one of the most beneficent of surgical procedures, is now considered by many surgeons as an unjustifiable measure in the treatment of peptic ulcer. On the Continent of Europe gastric resection has largely replaced the short-circuiting operation, but in Britain and in America opinion has not swung over to the more radical practice, at least in the treatment of duodenal ulcer.

Jejunal ulcer is unquestionably a serious condition and prevention is simpler than cure. Briefly stated, it occurs more frequently in men than in women, and is much commoner after gastrojejunostomy for duodenal ulcer than it is after the same operation for gastric ulcer. Its incidence is variously stated at from 2 per cent. to 40 per cent. by different writers, and it would certainly appear to be commoner among the Teutonic and Semitic races than among those of Anglo-Saxon stock. Whilst it is difficult to give accurate figures regarding a condition which is not always confirmed by operation, my own figures show the incidence to be approximately 3.5 per cent. of all gastrojejunostomies for ulcer. Further, it appears to occur much more frequently in patients who, before operation, had a high gastric acidity and little gastric retention. It occurs but rarely in patients with old-standing pyloric or duodenal stenosis and with low gastric acidity. It was in the treatment of the latter type of case that the reputation of the operation of gastrojejunostomy was founded, and had it been restricted to this type the problem of jejunal ulcer would not be the burning one it is to-day.

In my experience the most effective preventive measure is to avoid a gastrojejunal anastomosis in all cases of duodenal ulcer with high acidity and little or no stenosis, and to employ either gastroduodenostomy or some form of plastic operation at the pylorus in such cases. As infection is another factor in the etiology, the eradication of septic foci in teeth, tonsils, appendix and gall-bladder should form an essential part of therapy in ulcer cases. Further, the injudicious or heavy-handed use of clamps in the operation of gastrojejunostomy may determine an area of lowered vitality which may fall a prey to the acid chyme in the early post-operative period.

The tendency to regard the operation as the cure rather than as an incident in the treatment of peptic ulcer, with consequent failure to insist on care in diet and to exhibit alkalies during the early months of convalescence, is still all too common. The sensitive jejunum must be sheltered from hyperacid gastric juice till such time as it has acquired immunity, and any neglect to observe this reasonable precaution must inevitably lead to a high incidence of jejunal ulcer.

Pathology.—The distinction between gastrojejunal and jejunal ulcer is more of academic than practical interest. The suture alone will not determine an ulcer and, whilst devitalization at the suture line must of necessity play a part when the other ulcer-determining factors are operative, it is common knowledge that the ulcer is just as common at some distance from as on the line of suture. We may, therefore, consider the two types of ulcer as essentially one and the same. My experience leads me to believe that in the majority of cases the onset of jejunal ulcer follows hard on the operation although the recumbency and the initial care in diet, which characterize the immediate post-operative period, may to some extent mask the symptoms. Certainly it is true that the patient who complains of acidity and heartburn during the early post-operative stage is a strong candidate for the ranks of jejunal ulcer cases.

Apart from the persistent dyspepsia which is the common lot of sufferers from jejunal ulcer, certain alarming and disabling complications are frequently encountered. Some of these I will but mention, others I wish to deal with in greater detail.

Recurring hæmorrhage is the most frequent and the most difficult to treat. It calls for surgical treatment preceded by blood transfusion.

Perforation into the free peritoneal cavity, whilst uncommon, is always serious owing to difficulties of satisfactory closure without compromising the gastrojejunal outlet. If the immediate dangers are survived, a second operation, to treat the ulcer, is usually required and presents a formidable technical problem.

Subacute perforation with the formation of an inflammatory mass, situated to the left of the umbilicus, calls for conservative treatment until such time as the inflammatory reaction has subsided. Thereafter surgical interference must be undertaken. If the local conditions permit, the region of the anastomosis must be freed and a partial gastrectomy performed. When the patient's general condition is poor, and inflammatory infiltration of the mesocolon and root of the mesentery is such as to present formidable obstacles to a safe resection, I have found that reasonably good results follow a double short-circuiting operation, *viz.*, a gastroduodenostomy to exclude the old ulcer, and a duodenojejunosomy to exclude the region of the jejunal ulcer.

Penetrating Jejunal Ulcer.—It is usual to find the ulcer just at the stoma, alongside it or just beyond. Occasionally, however, the ulcer may be found in the jejunum proximal to the stoma. In such cases it may penetrate into the mesocolon and the posterior abdominal wall, just as a posterior gastric ulcer penetrates into the pancreas. Excision of such a penetrating ulcer may

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lead to a wound of the superior mesenteric vein and it should not be attempted. In a very pronounced example of such an ulcer in the proximal loop, a completely satisfactory result followed the removal of the gastroenterostomy stoma, closure of the stomach and the jejunum, the establishment of a gastroduodenostomy opening to exclude a stenosing duodenal ulcer, and a duodenojejunostomy to short-circuit the jejunal ulcer.

Secondary Duodenal Ileus.—I wish to draw attention particularly to the occurrence of duodenal stasis as a factor in both the pathological and clinical pictures of many cases of jejunal ulcer and especially cases of long standing. The tendency to thickening and fibrosis in the region of the stoma leads, on the one hand, to a gradual narrowing, and in some cases a potential, if not actual, occlusion of the gastroenterostomy opening, and, on the other hand, to an inflammatory induration of the root of the mesentery which interferes with the efflux from the duodenum. In the treatment of such old-standing cases special measures must be taken to drain the partially obstructed duodenum if complete relief is to be gained. In some cases drainage of the duodenum by the establishment of a duodenojejunostomy stoma may be all that is necessary; in others this operation must be associated with a direct attack on the jejunal ulcer and the original stoma.

The following two cases illustrate this point. They represent extreme degrees of the factor of duodenal obstruction, a factor which in minor degree is present in a large number of cases.

CASE I.—A. M., aged sixty-two. Twenty-five years ago had a gastrojejunostomy done for duodenal ulcer. He was well for some years then he began to have recurring attacks of indigestion and on two occasions had melæna. For the past ten years has had increasing discomfort after food, great flatulence and occasional vomiting of large quantities of fermenting bile-stained fluid. For the past five years had been in the habit of passing a stomach tube daily and washing out his stomach. Every now and then he would get attacks of pain and distention. He had to eat very sparingly and consequently had slowly but steadily lost weight.

On examination a large splashing stomach, and what was taken to be a splashing duodenum, were made out. A barium meal examination showed nothing passing through the stoma, great retention in the stoma and a mega-duodenum with great retention in spite of active writhing peristalsis. (Fig. 1.)

A diagnosis of jejunal ulcer, with stenosis of the stoma and pronounced secondary duodenal ileus, was made and operation with a view to draining the dilated duodenum recommended.

Operation.—A mass of fibrous tissue surrounded the area of the stoma, which was bound down over the root of the mesentery, and tightly stenosed. The first part of the duodenum showed the scar of an old ulcer but no stenosis. The duodenum in its second and third parts was greatly dilated and hypertrophied. There appeared to be no indication to interfere with the old stoma and accordingly a duodenojejunostomy was performed. He made a most rapid and gratifying recovery, lost all distention, regained his appetite and put on twenty-eight pounds in weight in the following three months.

In a weakly and emaciated individual, over sixty years of age, a direct attack on the site of the old ulcer would have been both meddlesome and dangerous. In this case the duodenal ileus had gradually come to dominate

the clinical picture and the one essential part of the surgical treatment was to drain the obstructed duodenum.

CASE II.—J. F., aged fifty-six. Twenty-two years before had a gastrojejunostomy done for "dyspepsia": no ulcer was seen at operation. Patient was never quite well following the operation and developed symptoms of jejunal ulcer some five years before the second operation. One day patient was seized suddenly with a very acute abdominal pain, suggesting a perforation. He was treated on conservative lines.



FIG. 1.—Gross duodenal ileus resulting from long-standing jejunal ulcer. Complete relief followed duodenojejunostomy.

Radiograms taken two weeks later showed that the barium was leaving entirely by the pylorus and that there was pronounced duodenal stasis. (Fig. 2.)

At operation there was induration and congestion round a narrowed stoma, and a dilated and hypertrophied duodenum bulged beneath the transverse mesocolon. The first part of the duodenum was dilated and showed no trace of ulceration. The stoma was freed, the opening in the stomach closed and the rent in the jejunum closed transversely. A submesocolic duodenojejunostomy was then performed. In spite of a stormy convalescence the patient made an excellent recovery and is now well.

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These two cases show in pronounced degree the development of chronic duodenal ileus as a result of jejunal ulceration. Minor degrees of the condition are more frequent and if demonstrated by X-ray examination should determine the establishment of duodenal drainage as one essential step in whatever operative procedure is adopted. Failure to overcome duodenal stasis will lead to persistence of discomfort and may, if the gastroenterostomy has been simply removed, lead to a recrudescence of duodenal ulcer. The



FIG. 2.—Duodenal ileus associated with jejunal ulcer. Complete relief followed removal of stoma and duodenojejunostomy.

following case, although not a true example of jejunal ulcer, illustrates the point in question.

CASE III.—J. P., aged twenty-eight, after some months of symptoms of duodenal ulcer, was seized with sudden abdominal pain, typical of perforation. He was operated on some hours later and a perforated ulcer of the duodenum exposed. The perforation was closed and a posterior gastrojejunostomy performed. After doing well for some days he commenced to vomit bilious material, and this continued for ten days during which time he became progressively weaker and developed generalized tetany.

He was given a barium meal and X-ray photographs taken, when it was seen that

the barium was leaving entirely by the pylorus and was held up in a greatly dilated duodenum.

A second operation was performed, at which the jejunum was detached from the stomach—*restitutio ad integrum*. The patient convalesced slowly and, although suffering from some indigestion and flatulence, was able to return to work. After some months duodenal ulcer symptoms returned, worse than ever before, and continued in spite of medical treatment.

Seen two years after his first operation, he was in poor health and suffering from persistent pain and flatulence.

X-ray examination showed that he had a large duodenal ulcer and marked stasis in a dilated duodenum. (Fig. 3.)

An operation to short-circuit the duodenal ulcer and to drain the dilated duodenum

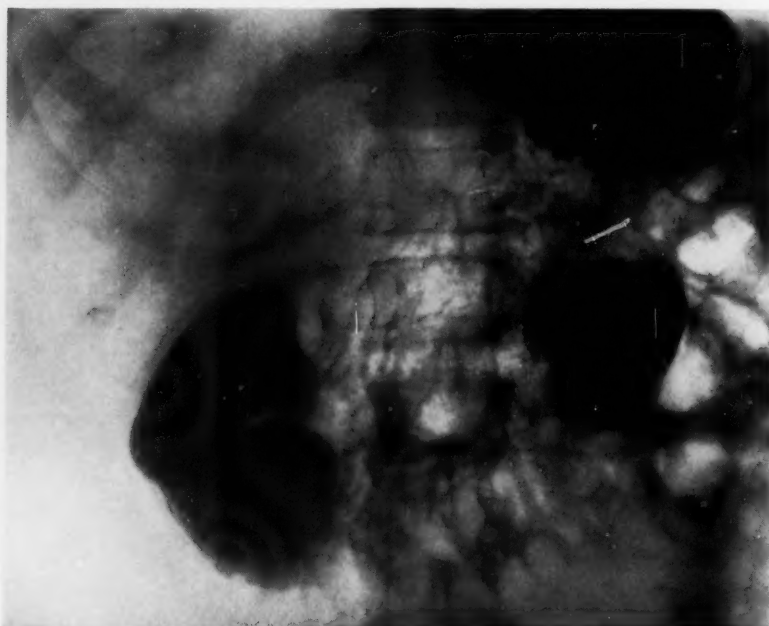


FIG. 3.—Chronic duodenal ileus persisting after removal of stoma with recrudescence of duodenal ulcer. Gastroduodenostomy and duodenojejunostomy gave immediate relief.

was recommended. This was carried out. It was found that in the first coil of jejunum and over the root of the mesentery there were thickening and fibrosis. A gastro-duodenostomy to exclude the first part of the duodenum, and a duodenojejunostomy to drain the duodenum, were performed.

The patient was immediately relieved of all his former symptoms and made a rapid and complete recovery.

In this case the conditions were exactly comparable to those found so often in jejunal ulcer cases, and the two-fold anastomosis which was made is the operative measure which can be carried out with comparative safety and success in such cases.

A Jejunocolic or a Gastrojejunocolic fistula.—This is always of grave import. The regurgitation of fecal matter into the stomach destroys all appetite for food and leads to characteristic anæmia, and the entry of par-

JEJUNAL ULCER

tially digested food into the colon causes persistent diarrhoea and loss of weight. (Fig. 4.) The stomach content is foul and septic and all endeavors to clean the stomach by lavage merely accentuate regurgitation of feculent fluid.

Operation under such conditions is always fraught with serious risk to life. The region of the fistula is found engorged and œdematous, the lymph-vessels leading from it are infected, and a clean resection is well-nigh impossible. The mortality from one-stage radical operation is very high (almost 40 per cent.). Where the fistula is small and the general condition of the patient has not been allowed by delay to deteriorate, a one-stage operation, freeing and closing the colon and dealing with the jejunum by resection, possibly followed by partial gastrectomy, may be feasible. In the majority of cases, where the patient's general condition is poor, I believe that a two-stage operation is advisable.

The following case of gastrocolic fistula revealed to me the advantages of a two-stage procedure.

CASE IV.—M. C., aged thirty-two. Troubled with stomach for ten years. Periodic attacks of pain coming on one hour after meals, associated with much flatulence and frequently accompanied by vomiting. For two years prior to admission the pain had been more persistent than ever before. Six months before coming to hospital he was awakened in the night with severe abdominal pain. He vomited on several occasions and noticed that the vomit was dark brown in color and feculent in odor. The pain lasted for twelve hours. It was diagnosed as being due to appendicitis and he was removed to his local hospital where his appendix was removed. During the five weeks he was in hospital he had constant feculent-smelling eructations. For six months thereafter he steadily lost weight from absence of appetite and persistent diarrhoea. The foul eructations made him shun company and live by himself. The patient was thin and emaciated. Pale with a tinge of cyanosis in lips, cheeks and ears. Nothing to be made out on abdominal palpation.

Barium meal and barium enema showed large fistula between stomach and splenic flexure of the colon. (Fig. 5.)

First Operation.—August 27, 1931. Gas and oxygen. Left paramedial incision. Fistula found between posterior wall of stomach near lesser curve and splenic flexure of colon. In the area of the fistula both stomach and colon were greatly congested and œdematous, and there was a considerable amount of fluid content in both viscera. It was deemed inadvisable to detach the colon from the stomach where both were fixed, infected and œdematous, and it was decided to exclude the portion of colon involved in the fistula. Accordingly the phrenicocolic ligament was divided and the splenic flexure mobilized. The colon was then divided by the cuff method, three inches proximal, and again three inches distal to the fistula. The ends of this isolated loop were then ligated and invaginated. An end-to-end anastomosis, with one row of interrupted linen sutures over clamps, was then performed to re-establish the continuity of the colon. (Fig. 6.) To minimize the risk of leakage a tube cœcostomy was performed. The patient made a rapid recovery.

Eleven weeks later patient was readmitted. He appeared to be in robust health. He had put on twenty-nine pounds in weight and had lost his anæmia.

X-ray examination showed a penetrating ulcer opening into the attached loop of colon.

Second Operation.—November 16, 1931. The loop of colon was found with dif-

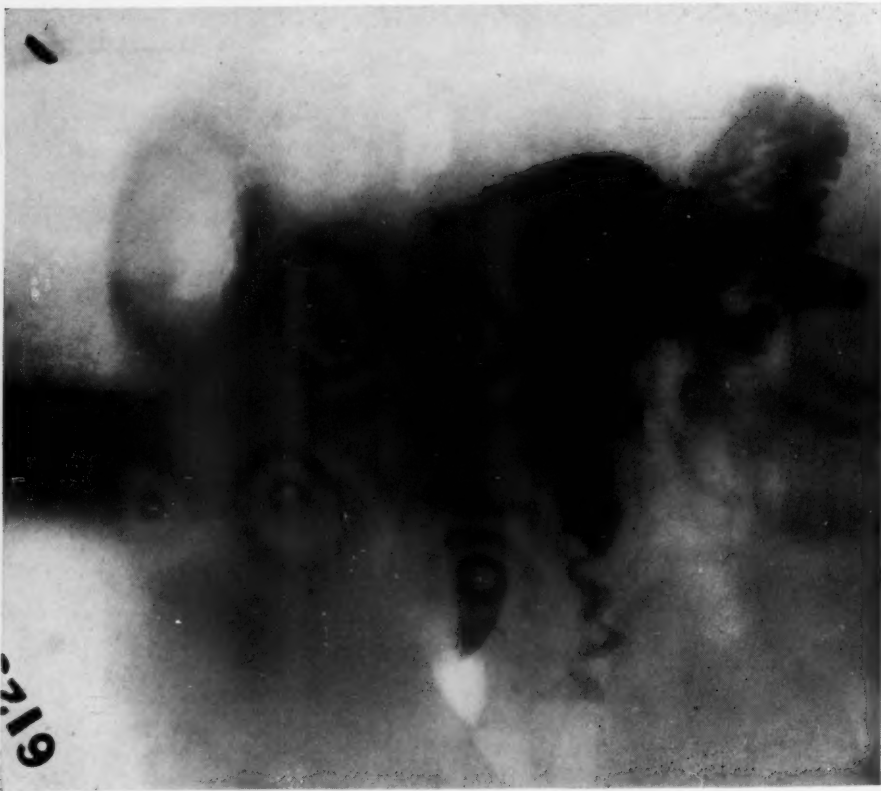


FIG. 4.—Gastrojejuno-colic fistula. Immediately after meal barium seen in dilated jejunal coil and transverse colon.

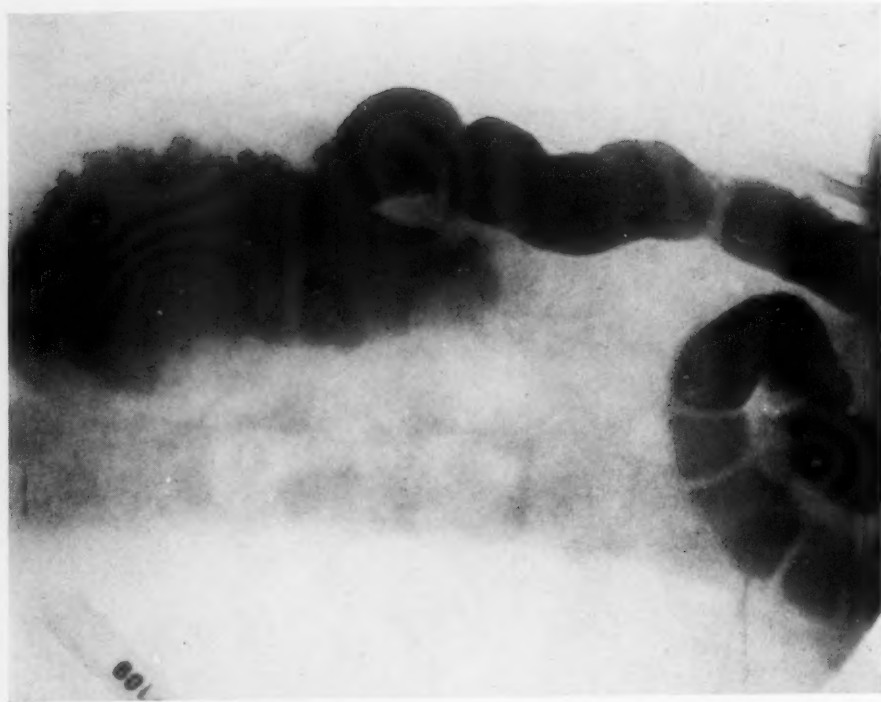


FIG. 5.—Gastrocolic fistula resulting from perforation of large gastric ulcer into splenic flexure. Opaque enema shows barium entering stomach.

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ficulty, buried in adhesions. It was practically empty and was pale in color. The loop was readily excised along with the gastric ulcer, and a portion of gastric wall around it.

Patient made a rapid recovery and has remained in good health.

I believe that the two-stage method practised in this case is the method of choice for the larger gastrojejuncolic fistulæ, where marked fecal regurgitation is occurring, where the patient is anæmic and all the tissues around the fistula are œdematous, friable and infected. By excluding the portion of colon involved in the fistula, and allowing a period of some weeks or months to elapse, a relatively clean field can be obtained for the second and major stage of the operation.

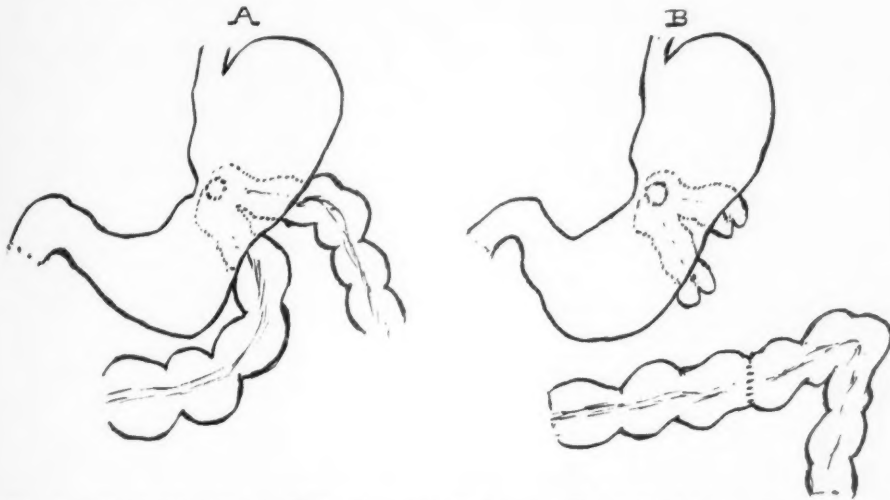


FIG. 6.—(A) Gastric ulcer perforated into splenic flexure. Gastrocolic fistula. (B) Portion of colon isolated, end-to-end union re-establishing continuity.

SUMMARY

(1) The two main factors in producing jejunal ulcer after gastroenterostomy are high gastric acidity and infection.

(2) A very high gastric acidity should be regarded as a contra-indication to gastroenterostomy—a gastroduodenostomy should be preferred.

(3) All septic foci in teeth, tonsils, appendix and gall-bladder should be dealt with in ulcer cases.

(4) Partial gastrectomy or removal of the stoma, followed by gastroduodenostomy, are the operations of choice in jejunal ulcer.

(5) The frequent occurrence of secondary duodenal ileus and the necessity for treatment of this by duodenojejunoscopy is emphasized.

(6) In dealing with cases of jejunocolic or gastrojejuncolic fistula, the advantages of a two-stage operation should always be considered.

OSTEOCHONDRITIS DISSECANS

INTRA-ARTICULAR OSSEOCARTILAGINOUS LOOSE BODIES

A CLINICAL STUDY BASED UPON TEN PERSONALLY OBSERVED CASES

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FROM THE SURGICAL SERVICE OF THE HARLEM HOSPITAL, DR. JOHN F. CONNORS, DIRECTOR

OF THE various joint conditions grouped under the term "internal derangement" due to loose bodies, that of osteochondritis dissecans is among the most unusual and interesting. The entity, whose obscure and confusing etiology is emphasized by the variety of synonyms used to describe it, is defined as a non-infectious process involving the articular cartilage and the subchondral region of certain long bones of the extremities. This process, by sequestration from the articular cartilage, produces a loose body which is osseocartilaginous in nature and whose structure undergoes curious alteration within the joint cavity.

A myriad of names have been employed to indicate the several characteristics of this disorder and among them are found such descriptions as "Paget's quiet necrosis of joints," "subchondral fracture of the articular condyle," "osteochondrolysis traumatica," "malacopathia of the joint," "partial necrosis of the epiphysis" and "arthrolithiasis of unknown origin."

Before reviewing the etiology and the pathogenesis it should be mentioned that the majority are most often found in the knee-joint and less commonly in the elbow-joint. In our series of ten cases, eight were cases in which the knee-joint was the site of the disease and two in which the elbow was involved.

In the knee-joint, osseocartilaginous bodies may arise from three distinct anatomical sources:

- (1) From the articular surfaces of the femur, patella and the tibial head and most commonly in the femur from the lateral aspect of the medial epicondyle.
- (2) As osteophytes in the process of an osteoarthritis by a breaking away of the diseased tissues.
- (3) As a result of proliferative changes in the synovial membrane as represented by the entity known as synovial osteochondromatosis.

In our series, the origin of the fragments found in the knee-joint at operation was as follows:

From the lateral aspect of the medial epicondyle of the femur.....	6 cases
From the lateral epicondyle of the femur (medial aspect).....	1 case
From the articular surface of the patella.....	2 cases

Etiology.—From an analysis of the evidence for and against the several theories of origin of the classical loose bodies that have been described with

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this condition, one is led to the conclusion that an entirely satisfactory explanation has not yet been offered. Trauma, low-grade bacterial infection, congenital predisposition of the femoral epiphysis, mycotic embolus, have been described as being among the factors thought to be of importance in the production of the condition. Wagoner and Cohn⁴⁵ reviewed the literature with reference to theories of etiology and offer the possibility of heredity as a factor in the production of these osseocartilaginous plaques from the femoral condyle.

(a) *Trauma*.—Monro (1738), Riemar (1770), and Haller (1776) were convinced of the traumatic origin of these loose bodies from the femoral condyle. Kragelund (1887)⁷ postulated a trauma of the "bone-cartilage region" followed by a sequestration of the area owing to a chronic inflammatory process. He reaffirmed the observation of Paget^{3, 4} that it was impossible to detach a fragment of articular cartilage simply by a blow. Axhausen (1914)¹⁵ postulated the idea that "as a result of the impaction from the opposing articular surface, the blood-vessels to the part are damaged, either with or without partial fracture, according to the severity of the violence. This leads to necrosis of the area supplied by the damaged vessels and as a result there forms a zone of absorption resulting in gradual separation and eventual extrusion of the dead portion of the articular surface into the joint." Hellstrom (1922)²⁴ declared that "the joint mice in osteochondritis dissecans are the result of a subchondral impression fracture. Excessive effort due to special structural conditions of the knee-joint may lead to the production of these fractures." Hence, individual predisposition and the failure of firm healing of the fracture play a part in the development. Kappis (1920)²⁰ indicated that in the knee and elbow which are the common sites of loose bodies, tangential and rotating forces may act on the convex surface of the condyle and fissure or partially or completely detach portions of the articular end. He believes that loose bodies arising from the patella are the result of tangential forces. To explain the traumatic origin in the absence of serious injury, he assumed a predisposition as the result of disease or congenital disturbance of the articular cartilage.

With the adherents of this factor, the etiology of the "joint mice" is, therefore, only a question of mechanics of joints and muscles and the histological pictures are the expression of a reaction of the tissues to a trauma under certain mechanical and anatomical conditions.

(b) *Embolism*.—This explanation has been founded on the postulates that, first, mycotic-embolic closure of an epiphyseal artery may lead rapidly to epiphyseal necrosis; secondly, the bacteria deposited may be vanquished by the body so that an infection does not take place and the necrosis remains aseptic. Thirdly, the joint bodies may develop *in situ*, therefore, from the aseptic epiphyseal necrosis by a process of demarcation. Although the epiphyseal arteries are not terminal arteries in the anatomical sense, inasmuch as fine lateral connections may be demonstrated, still, the anatomical findings do not prove that the functional capacity of these fine connections is suffi-

cient to insure nutrition of the epiphyseal region following closure of the chief arterial trunk.

Observations in osseous tuberculosis seem to prove that the lateral connections do not suffice and that the epiphyseal arteries are "functional end arteries," and that if they are occluded there must be an interruption of nutrition in the area they supply. The tuberculous wedge-shaped necrosis in the lower epiphysis of the femur with its apex directed towards the diaphysis may very well correspond to a single epiphyseal vessel area.

(c) *Congenital predisposition* of articular cartilage was offered by Kappis²⁰ as an explanation in cases where severe injury was absent.

(d) *Bacterial Factor*.—Knaggs,³³ in his conception of the "quiet necrosis of Paget," or, as he describes it, "necrosis without suppuration," believes that the initial lesion is a periostitis due, no doubt, to a microörganic infection of a very mild kind; probably staphylococcic in type. The infection invades the surface of the bone, but, owing to its feeble virulence, is speedily limited and fails to penetrate the deep surface of the compact bone.

Granulation tissue developing under the periosteum and in the Haversian canals of the superficial layers causes compression of the vessels and interferes with the blood supply of the compact bone in its deeper parts. By itself, this would not be sufficient to cause death, if the blood supply to the interior of the bone were adequate. If, however, the nutrient canal is similarly invaded, compression of the artery will seriously curtail the supply of blood to the medulla and render the circulation within the bone unequal to the demands upon it. Thus the compact bone, being gradually deprived of its blood supply, or receiving an inadequate supply, slowly passes into a state of necrosis.

In summarizing the etiology of the condition, it may be stated that the lesion does not seem to be a complete intra-articular fracture. If this were the sole reason for its being, then fragments detached from surfaces other than the lateral surface of the mesial epicondyle of the femur, the patellar surface and humeral capitellum should as regularly persist as loose bodies in the joint, which is not the case. Incomplete or subchondral fracture passing between bone and cartilage has probably the greatest number of adherents.

Were this the entire story, the partial fixation of the fragment would favor union with the bed from which it was dislodged and this is not found to be so when the joint is opened.

It is possible that the cause of the non-union is systemic and is not understood as with the certain percentage of ununited fractures of the tibial shaft.

As for the absence of a history of trauma in these cases, a fact frequently noted, it is to be remembered that the articular cartilage is devoid of nerve supply and there is extremely little sensation in the cancellous bone which it overlies. For this reason, it is possible that a fracture of the articular surface might result from undue violence and be accompanied by little or no pain. Such injuries would easily be overlooked or forgotten, and

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this would account for the frequent absence of a history of trauma of such violence as would ordinarily be considered necessary to produce such changes. In conclusion, the most logical explanation seems to be that which allows for a preliminary trauma to a non-sensitive articular surface with subsequent injury to a functional end-artery. Following the vessel damage and thrombosis, a localized area of necrosis results with sequestration of a fragment from the articular surface.

Pathology.—Stages of the Process.—Upon entering the joint, and especially in the knee-joint, a rather typical picture presents itself. As has been observed in this joint, the commonest site is the lateral aspect of the medial epicondyle of the femur. There are three distinct phases, stages or types of pathological picture which correspond to the extent of the process and to the degree of sequestration of the fragment.

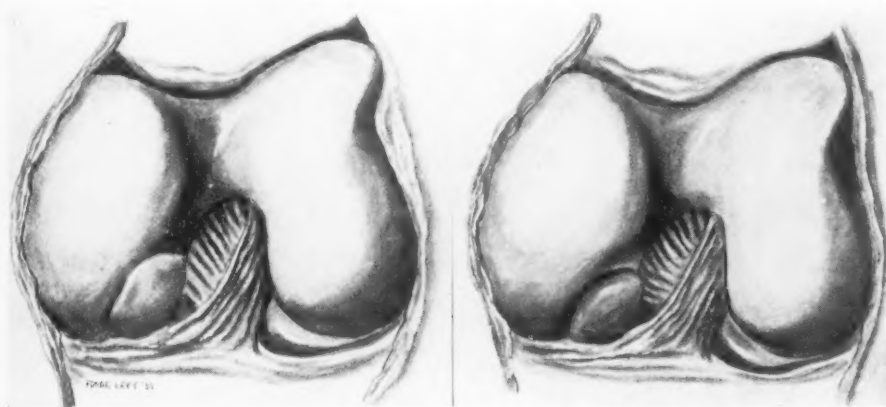


PLATE I.

PLATE II.

PLATE I.—Illustrating the type of case which shows a fairly well demarcated prominence of the articular surface, with the articular cartilage covering this elevation of a different color than the rest of the cartilaginous surface.

PLATE II.—Illustrating the type of case in which the fragment has become more distinctly separated and lies within the excavated area, being held there by a small adhesion.

In the first stage, there may be only a fairly well demarcated prominence of the articular surface with the articular cartilage covering this elevation of a different color than that of the rest of the cartilaginous surface. (Plate I.) If this prominence be excised during this period of the disease, and, as a rule, it is rather easily separated, a beginning excavation of the cancellous subchondral portion of the articular end of the bone may be observed. The ease with which this articular osseocartilaginous prominence may be removed is in striking contrast to the difficulty with which normal articular cartilage is removed from the end of any normal femoral articular surface.

The second stage in the process we recognize is one in which the fragment has become more distinctly separated and lies within the excavated area of the articular surface, being held, perhaps, by the merest shred or by a fairly firm adhesion. (Plate II.)

This fragment is easily removable; in fact, it may be merely lifted out of its bed. Surrounding this excavation, which resembles in character the bite of a rodent, the articular cartilage is of a peculiar appearance, having an ivory-like cast and in contrast with the normal articular cartilage, appears actually buff-colored. In addition to this color change, the cartilage is not firmly attached to the articular end of the underlying cancellous bone, but is easily removable for a varying distance from the sequestered focus. The ease with which it may be lifted gives it the actual appearance of having

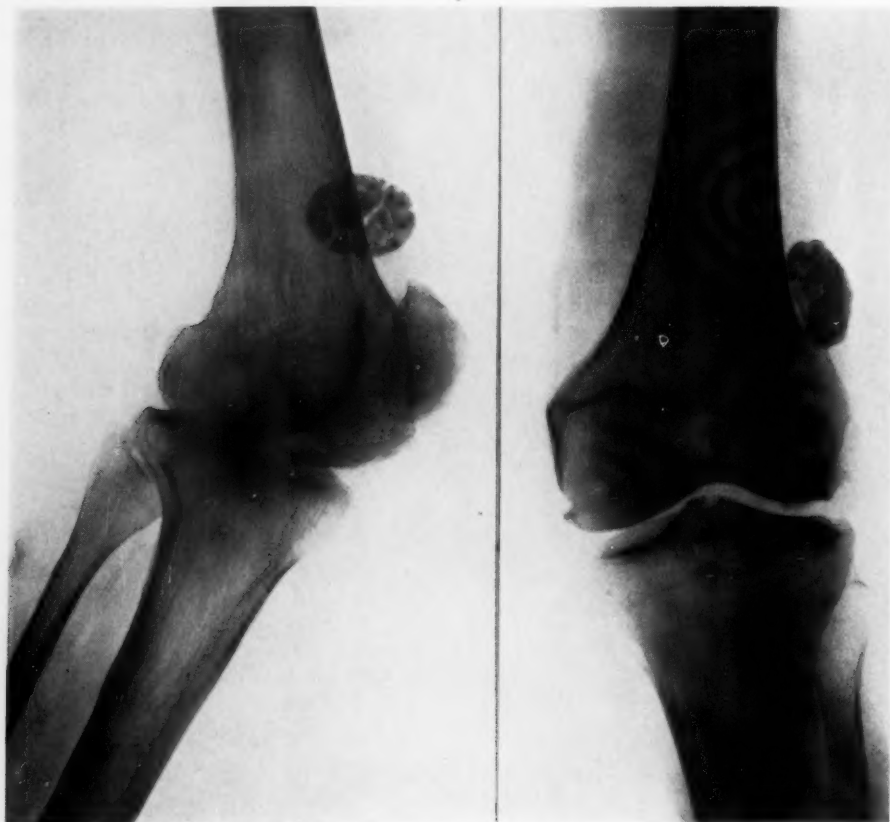


FIG. 1.

FIG. 2.

FIG. 1.—(Case VI.) Radiograph illustrating the lamellation of loose body within knee-joint. Injury to joint twenty-five years prior to admission to hospital. Patient was informed at time of accident that loose body was present but refused operation at that time. Case regarded as being of Type III, with complete sequestration of the fragment from articular surface into joint cavity.

FIG. 2.—(Case VI.) Anteroposterior view of radiograph shown in Fig. 1, demonstrating the position of the loose body within the quadriceps bursa.

been dissected off and this characteristic is expressed in the name "osteochondritis dissecans," which was first applied to this condition by König,⁶ in 1887.

The third stage is merely the completion of the first two periods and is characterized by the complete sequestration of the fragment from its place on the articular surface into the joint cavity. The fragment may remain

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freely movable within the joint cavity, being bathed by the synovial fluid and become lamellated in structure by a process of accretion (Figs. 1 and 2, Case VI), or it may become affixed to the synovial wall of the joint. The excavated cavity presents of itself no distinctive features, being lined by a thin velvety layer of reddish-gray tissue. Curettings of these foci do not reveal any specific pathological picture which would indicate anything of a specific nature of the process. Cultures of the curettings removed at operation have all shown no bacterial growth.

The excavation gradually becomes filled in with fibrocartilage and in outline becomes shallower and less pronounced.

The Fragment.—Following the loosening of the fragment from the articular surface, degenerative and regenerative changes occur in it, both while it is attached by a pedicle and after it has been completely extruded within the joint.

While it is attached by a pedicle, it may be nourished through blood-vessels existent within the stalk of the pedicle and the degenerative changes in the fragment be slight. However, both the articular bone and cartilage tend to a general necrosis. In some cases, the proliferative changes may be considerable during this period and in the microscopical sections evidences of osteoblastic formation may be seen. Principally, the proliferative changes consist in the formation of fibrocartilage along the surface of separation—but in the area where bone is present, there may be considerable new bone production. This proliferative process is most marked in the cancellous spaces along the zone of separation, and the old bone which becomes necrotic may be replaced by new bone.

After complete liberation within the joint, all bone which has had a blood vascular circulation becomes necrotic and there is still further necrosis and calcification in the articular cartilage. The fibrocartilage and the fibrous tissue along the surface of separation receive sufficient nutrition from the synovial fluid and proliferate, thus causing a slow but steady increase in the size of the loose body. The fibrocartilage gradually absorbs and replaces the necrotic articular cartilage and less rapidly the necrotic bone, so that years after separation, the original constituents of the loose bony fragment may have completely disappeared. In many specimens removed from the joint, years after complete separation, a definite lamellation may be seen to have occurred and in one of our cases (P. M.), an arthrolith (Figs. 3 and 4) presents just such an appearance. A sagittal section through this body indicates the laying down of the lamellæ around the original fragment. Concomitant with this laying down of fibrocartilage about the original particle, calcification occurs within the layers of the fibrocartilage and an extremely pathological type of new bone may be formed in its superficial portion. (P. M., Case VI.)

The Synovial Membrane.—With regard to the synovial membrane lining the joint, one may state that the character of it will depend upon the amount of irritation that has been offered to it as the result of trauma from the

loose fragment or fragments, the extent of the hemarthrosis existent and the length of time these two factors have been present. Changes in the synovia from a simple cedema of the synovial papillæ to a pronounced hypertrophy of the individual and multiple single papillæ which have been in direct contact with the offending loose fragment have been observed. (Case

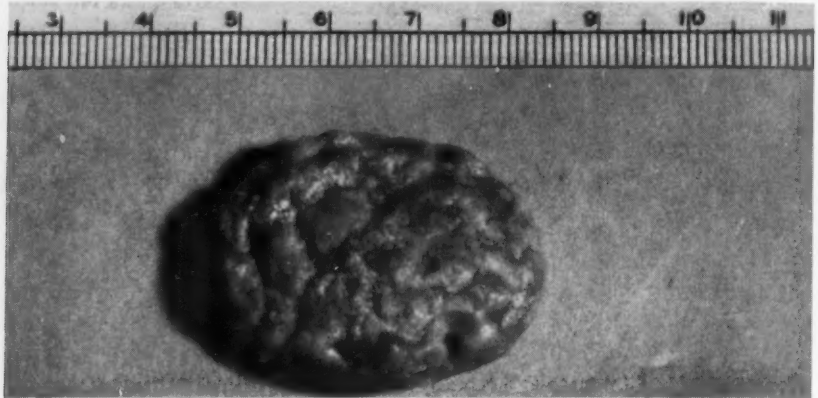


FIG. 3.—(Case VI.) Arthrolith removed from knee-joint illustrating a complete change in the character of the sequestrated fragment.

I, T. D.; Case IV, A. S.) The extent of this traumatic hypertrophic synovitis and its striking subsidence within a short interval following arthrotomy with the removal of the loose fragments is quite pronounced. With persistent trauma from the loose particles, joint changes of an osteoarthritic nature will result within the joint.

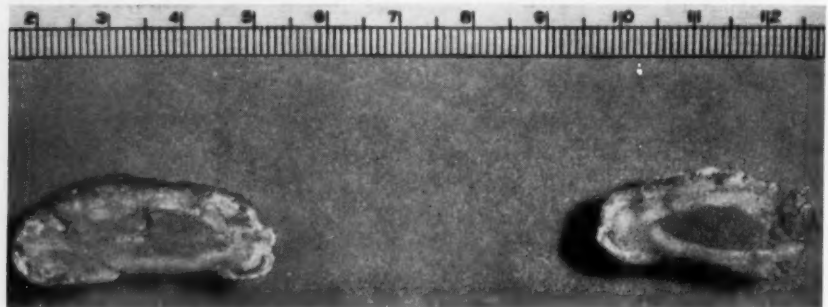


FIG. 4.—(Case VI.) Sagittal section of the arthrolith shown in Fig. 3, indicating the lamellated character of the fragment as the result of the action of synovial deposition upon the original loose body.

The plates marked I, II, and III and the schema (Plate IV) accompanying them indicate the types of cases presented in this review and show rather clearly the variations one encounters on opening the joint.

Chemical analyses were made of the synovial fluid in several of the cases but were not found to be of any especial import and for that reason the values obtained are not reproduced in this report.

As to the pathological grouping of loose bodies that appear in joints, the following outline of Timbrell-Fisher's²² has seemed to the author to be the

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most inclusive. It is inserted at this point with an idea of demonstrating the place given to the group included under the name of "osteochondritis dissecans" in its relation to other loose joint bodies.

Loose Bodies of Cartilage and Bone May Be Divided into Three Groups

Group I.—*Loose Bodies Occurring in Connection with Some More or Less General Pathological Condition Affecting the Joint as:* (a) Osteoarthritis. (1) Detached osteophytes. (2) Detached epi-articular ecchondroses as a result of lipping of patella. (b) Tabes dorsalis. (c) Tuberculosis of joint accompanied by necrotic caries. (d) Acute arthritis due to infection.

Group II.—*Loose Bodies Occurring in Joints that Are Otherwise Apparently Normal.* (a) Bodies having the microscopical and sometimes the macroscopical appearances of detached portions of the articular surfaces (osteo-

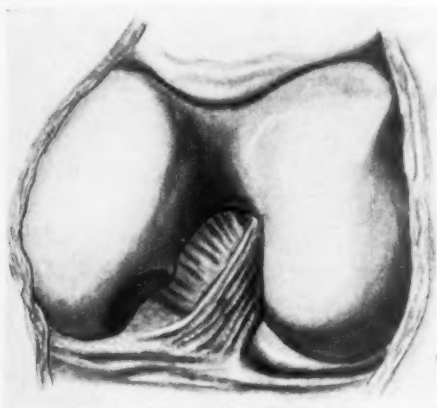


PLATE III.

PLATE III.—Illustrating the type of case characterized by complete sequestration of the fragment from the articular surface.

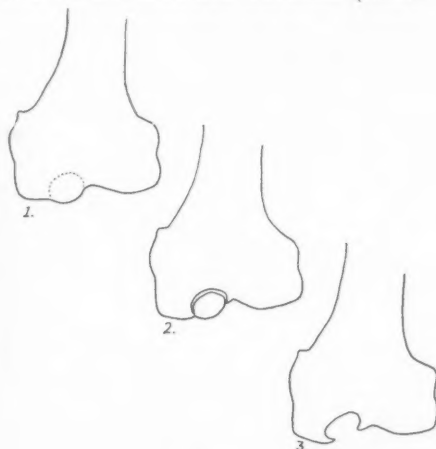


PLATE IV.

PLATE IV.—Schema illustrating the variations encountered.

chondritis dissecans). (b) Bodies derived from the intra-articular fibrocartilages. (c) Bodies formed from detached epiphyses not forming portions of an articulating area.

Group III.—*Synozial Chondromata, Laminated and Non-laminated.* (a) Single. (b) Multiple. (c) Diffuse.

In concluding the pathological discussion the following summary serves to coördinate the several facts elaborated above:

(1) The condition is more often seen in males than in females.

(2) The average age is from fifteen to thirty-five years; in our series, the youngest was seventeen and the oldest case fifty-two years of age, with an average age of thirty.

(3) Fragments may be: (a) *Recent detachments:* Where bone and cartilage are living and there are no proliferative changes in the articular cartilage. It is in these cases where there is no sign of any morbid process that

the clinical evidence strongly supports the traumatic origin of this group. (b) *Bodies whose sojourn in the joint has been longer*: Where the articular cartilage shows proliferative changes. (c) *Where there is marked degree of cartilage proliferation*. (d) *Where cartilage proliferation is excessive*. (e) *Where cartilage proliferation is feeble*.

(4) Commonest site is the knee; next is the elbow.

(5) The condition is usually unilateral.

(6) Bodies may be completely or incompletely detached or may acquire a secondary adhesion to the synovial membrane. When incompletely separated, they are usually attached by a hinge of articular cartilage to the margin of a defect or loss of substance on the articular surface which corresponds in size and shape to the loose body.

(7) Their continued presence in a joint may bring about changes of an osteoarthritic nature.

Symptomatology.—The onset of the classical symptoms is determined usually by the extent of the pathological process and the degree of demarcation of the sequestered fragment. The interval occurring between an injury and the onset of the commoner symptoms is greatly stressed by those investigators who regard the process as an aseptic necrosis. However, the interval can be quite satisfactorily explained if one bears in mind the fact that the classical symptoms are due to the loose body being caught between the articular surfaces, thus giving rise to sudden attacks of pain or even locking. If a loose body has become attached to the synovial membrane in such a position that it is unable to wander freely about the joint or get between the articular surfaces, or if it has not completely been detached and occupies the excavation in the articular surface, then the symptoms may not arise; with its disengagement, however, they will manifest themselves.

In the group of cases which we have called the first type (Fig. 5), where the radiograph reveals merely a line of demarcation of the femoral condyle (Case I, T. D.), there is usually a history of indefinite symptoms of weakness and disability for a long period (two months to two years). The knee is described as not being as strong or as reliable as the other. Often there is a history of the affected part not being able to stand up under strain as well as the opposite member. With these indefinite early symptoms which are characterized by the general feeling of disability not quite amounting to pain, is the absence of locking or "catching" of the knee-joint. It may readily be appreciated why the onset of symptoms of osteochondritis dissecans is so insidious as compared to the rapidity of the symptomatology in a dislocated cartilage. With the dislocated cartilage, there is, at the onset, an interposition of the curled meniscus between the articular surfaces of the femur and the tibial head and hence locking and fixation of the knee occur immediately. With the further sequestration of the fragment, but without complete loosening, the symptoms of locking and synovial membrane involvement occur. With osteochondritis dissecans, these disabling features do not occur at the onset but are a rather late occurrence and are preceded

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by a long history of indefinite knee-joint dysfunction. This train of symptoms we have described as belonging to the second stage of the process. It is only a matter of time when the fragment now will become completely detached and wander about the joint and in addition to the symptom of locking, the presence of a loose body becomes manifest to the patient himself. (Figs. 6, 7, and 8.)

In the third stage, with the completely sequestered fragment within the knee-joint, the symptoms elicited in addition to an occasional attack of locking (and which in this stage is not as prominent a symptom) are those refer-



FIG. 5.

FIG. 6.

FIG. 5.—(Case I.) Radiograph reveals a line of demarcation in the internal aspect of the external condyle of the femur. The arrows indicate the area of sequestration. This case is regarded as being Type I in character. In addition, the lateral view shown in Fig. 6 reveals the presence of two calcific bodies in the quadriceps bursa.

FIG. 6.—(Case I.) Lateral view of radiograph shown in Fig. 5 showing the presence of the calcific bodies in the quadriceps bursa.

able mainly to the synovium. For this reason swelling of the knee is the most persistent and annoying feature. This is due to first, a hypertrophy of the synovial membrane itself in the form of a traumatic hypertrophic synovitis and secondly, to an increase in the synovial fluid contained therein, and is an expression of synovial reaction to repeated traumata from the loose fragment. During this period lamellation of the fragment occurs by deposition.

In our series of cases, the symptoms in order of their frequency were: pain, disability, swelling and the presence of movable body. Objectively, the knee may or may not present any especial gross abnormality, for the appearance will vary with the duration of the disease, the extent of the synovial involvement and the degree of hemarthrosis present. In the majority of our cases, the knee was slightly swollen with a visible fullness in the quadriceps bursa. Flexion and extension were limited as would be expected, although in many instances, the amount of motion would vary, due, no



FIG. 7.



FIG. 8.

FIG. 7.—(Case IV.) Radiograph illustrating type regarded as Type II, where the sequestrating fragments are merely held to the excavated area in the articular surface of femur by a small adhesion.

FIG. 8.—(Case IV.) Lateral view of radiograph shown in Fig. 7.

doubt, to a shifting of the loose fragments within the joint cavity. Loose bodies were felt in two of our cases prior to arthrotomy (Case VI, P. M.; Case I, T. D.) and the findings verified by the röntgenograms.

Radiographical Evidence.—The radiographical picture is diagnostic and presents a characteristic appearance. In the knee-joint, the variations will depend again upon the degree of separation of the fragments. In the early stages, before complete demarcation has occurred, a rarefaction of the articular surface of the femur is present with a linear outline of the excavated

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area presenting. (T. D., Fig. 5.) Most commonly in the femur this is seen in the region of the lateral aspect of the medial epicondyle, although in the figure shown it is the internal aspect of the lateral epicondyle. With progression of the process, this linear rarefaction develops into a definite demarcation and finally into a completely excavated crater with a loose body freely movable within the knee-joint. With our cases, stereoscopical plates of the affected joints were made and proved invaluable in the detection of the condition where the cases came under observation in the early stages. In the later stages, although recognition was readily made with the plain A-P and lateral views, we found that the pre-operative stereoscopical plates afforded additional information in giving an idea as to the extent of involvement of the femoral articular surface. In the cases where the condition was of long standing and where the loose fragment had become lamellated as the result of synovial deposition on the sequestered fragment, the radiograph indicated this concentric deposit and Fig. 1 (P. M.) is a rather striking illustration of this effect.

Treatment.—The treatment of osteochondritis dissecans is arthrotomy with the removal of the sequestered fragments. In cases where the fragment lies in the excavation and is not completely detached we have removed the piece and curetted the excavation. In cases where the cartilage is loosened about the edges of the crater-like depression in the articular surface of the femur, we have removed it for varying distances about this edge; the amount depending entirely upon the degree of undermining which has occurred.

The optimum time for intervention is during the stage of demarcation, before complete sequestration has occurred as the degree of synovitis is at a minimum at that time. It will be readily appreciated that with the advancement of a marked synovitis, the residual dysfunction will be increased and the convalescence prolonged.

With reference to the technic employed, a word should be said to what we believe to be the most important single step in the procedure and that is the pre-operative skin preparation. It has been our custom to subject these cases to a forty-eight-hour pre-operative skin preparation usually supervised and sometimes performed by the operator himself. The incision employed has been the rather standardized longitudinal parapatellar incision which can be extended to suit the needs of the operator and which will allow easy lateral or medial retraction of the patella. In our experience this approach has been the simplest and has given the most satisfactory exposure with the least amount of damage to the peri-articular structures.

The convalescence of these cases was entirely uneventful and motion was started by the patient himself on the twelfth to the fourteenth day after operation. For a period of four to five weeks after being discharged from the hospital they all returned to the surgical clinic where physiotherapeutic stimulation in the form of baking to the knee and massage of the quadriceps

TABLE I
Analysis of Cases

Case Admitted and Discharged	Days in Hospital	Age	Sex	Joint	Disability	Predominating Symptoms	Duration	Previous Trauma	Operation	Location of Fragments	Function	Result
Case I.—T. D. 9-30-31 10-10-31	16	25	M	Left knee	E—135° F—90°	Pain; limitation of motion; palpable loose bodies	5 yrs.	+	Arthrotomy with removal of loose bodies	External condyle of femur	At 6 mos., E—180°, F—100°	Satisfactory
Case II.—C. J. 11-25-31 12-15-31	20	23	M	Left knee	E—135° F—90°	Pain; swelling	2 yrs.	0	Arthrotomy with removal of loose bodies	(1) Internal condyle of femur; (2) patella	At 6 mos., complete restoration	Excellent
Case III.—J. N. 10-20-31 11-17-31	19	39	M	Left knee	E—0° F—0°	Disability; swelling	3 mos.	0	Arthrotomy with removal of loose bodies	Internal condyle of femur	At 18 mos., complete restoration	Excellent
Case IV.—A. S. 12-13-31 12-30-31	17	20	M	Right knee	E—0° F—0°	Swelling; pain	8 mos.	+	Arthrotomy with removal of loose bodies	Internal condyle of femur	At 18 mos., complete restoration	Excellent
Case V.—G. M. 3-22-32 4-6-32	15	32	M	Left knee	E—145° F—95°	Pain; swelling	2 mos.	+	Arthrotomy with removal of loose bodies	Internal condyle of femur	At 6 mos., complete restoration	Excellent
Case VI.—P. M. 5-23-32 6-16-32	24	52	M	Right knee	E—120° F—90°	Palpable loose body; swelling	25 yrs	+	Arthrotomy with removal of loose bodies	Internal condyle of femur	At 5 mos., complete restoration	Excellent
Case VII.—L. T. 10-28-32 12-8-32	41	17	M	Right knee	E—0° F—0°	Pain	1 day	+	Arthrotomy with removal of loose bodies	Patella	At 3 mos., E—180°, F—100°	Improved
Case VIII.—M. S. O. P. D.	—	45	M	Right elbow	—	Swelling	4 mos.	+	Non-operative	Capitulum of humerus		With physiotherapy symptomatically improved
Case IX.—M. S. O. P. D.	—	28	M	Right knee	E—135° F—90°	Pain; swelling	3 mos.	+	Non-operative	Internal condyle of femur		With physiotherapy symptomatically improved
Case X.—B. J. O. P. D.	—	30	M	Right elbow	—	Pain; disability	6 mos.	+	Non-operative	Capitulum of humerus		With physiotherapy symptomatically improved

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femoris were employed. The average period of disability in these cases was from eight to ten weeks.

The follow-up in these cases was rather satisfactory. Six of the seven operated cases reported regularly once a month for a period of six months and three continued for more than a year. The three non-operated cases continue under our observation at the present time. They are all receiving symptomatic relief from baking treatments to the affected part—undoubtedly owing to a defervescence of the synovitis existing within the joint.

CONCLUSIONS

(1) The condition of osteochondritis dissecans is more frequent than is assumed, ten cases having been isolated over a two-year period.

(2) Three types, stages or groups of the process are postulated and the varying symptomatology will depend upon the type, the degree of sequestration of the fragment, and the amount of synovial irritation that has occurred.

(3) There is nothing specific in the pathological picture, all degrees of bone and cartilage transformation being observed in the loose bodies removed at operation. Deposition upon loose bodies is demonstrated by the section of a fragment which had been within a knee-joint for twenty-five years.

(4) The radiograph is usually pathognomonic and stereoscopical views of the affected joints are invaluable in the determination of the amount and degree of articular damage.

(5) The treatment is arthrotomy with the removal of the loose fragments and the optimum time for surgical intervention is during the period of demarcation before any great degree of synovial change has occurred.

(6) The cases followed for more than one year showed no regression or return of the condition either symptomatically or radiographically.

CASE REPORTS

CASE I.—(T. D.) Colored male, aged twenty-five, chauffeur by occupation, was admitted to the Surgical Service of Dr. John F. Connors, September 30, 1931, with the complaint of acute pain and swelling of the left knee of five weeks' duration. He states that five years ago (1926) he dropped a piece of steel on the left knee and that shortly thereafter his knee became swollen. At that time he was informed that he had "rheumatism" and hot fomentations were advised. The external applications of heat reduced the swelling somewhat but did not completely remove the "soreness." Five weeks ago he twisted his knee and since that time the knee has remained swollen. Walking is impossible without the aid of crutches. There is no other joint involvement.

Past History.—Negative except for influenza in 1918. G. C. and lues denied.

Physical examination, negative except for the left knee-joint which is swollen. Extension to 135° and flexion of knee to only 90°. Palpation of the quadriceps bursa gives sensation of palpable intra-articular bodies.

Radiograph.—(No. 10519.) Left knee: In the anteroposterior view there is an area of demarcation of region of the external condyle of the femur at its internal aspect. Fragment appears to be sequestering from the articular surface. In the lateral view two calcific bodies may be seen in the region of the quadriceps pouch. Stereoscopical views of joint.

Diagnosis.—Osteochondritis dissecans, left knee-joint.

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The knee-joint was prepared in the customary manner for forty-eight hours prior to operation.

Operation.—(October 2, 1931.) A five-inch parapatellar incision was made lateral to the patella and extending from the region of the suprapatella bursa down to the head of the tibia. The joint was opened and in the quadriceps pouch a calcific body was found about the size of a small walnut. Lateral and below, a similar calcific body was seen attached by a small cartilaginous pedicle to the synovial lining of the knee-joint proper. The entire synovia was red and injected and in one or two places seemed to give evidence of a definite villous synovitis. On flexing the knee a clicking noise was elicited and it was seen that there was a definite obstacle to complete knee-joint function. It was thought that another incision was more advisable and for that reason a similar incision was made on the medial side of the patella. On the inferior surface of the lateral epicondyle a small osseocartilaginous plaque about the size of a twenty-five-cent

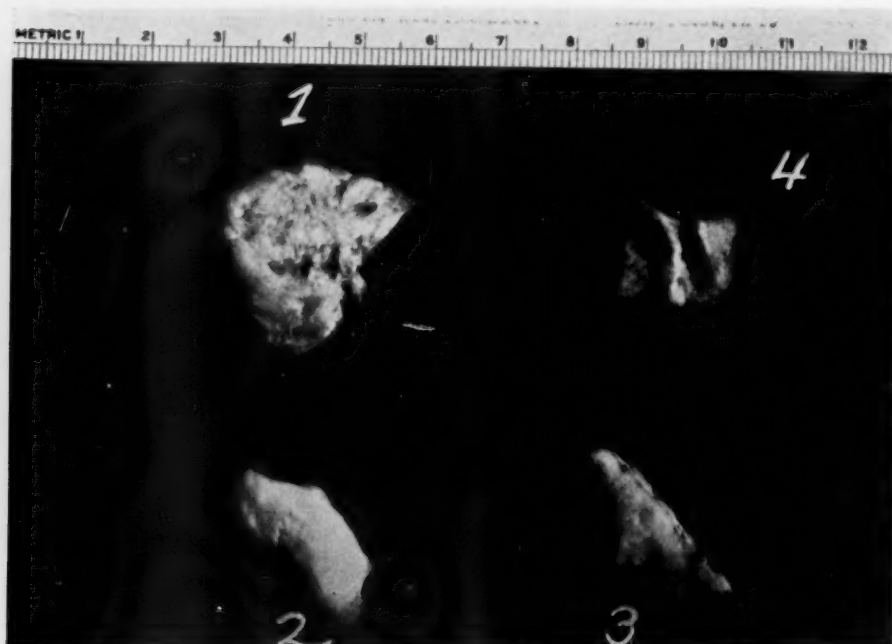


FIG. 9.—(Case I.) (T. D.) Fragments removed from the knee-joint. (1) Plaque from the articular surface of the femoral condyle (external). (2) Loose body removed from the quadriceps pouch. (3) Loose body present in the quadriceps pouch, showing pedicle attachment. (4) Hypertrophied villus present in the joint.

piece was seen rather firmly adherent to the condyle of the femur. This was removed, and, following its removal, motion at the knee became quite free and unrestricted. The cartilage of the femoral condyle in the region of this excavation was fragile and was removed for an area of about three-quarters of an inch surrounding the eroded portion. It was buff-colored in appearance and was of an entirely different character than the cartilage covering the rest of the articular surface. The joint cavity was irrigated with normal saline and the capsule closed in layers with No. 0 chromic catgut and bleeding points were secured and a continuous silk stitch was used for the closure of each incision. A firm molded plaster-of-Paris splint was applied with the knee in slight flexion.

Pathological Report.—Gross specimens are shown in Fig. 9. *Microscopically* reported as necrotic subchondral bone undergoing decalcification and absorption.

Post-operative Course.—Uneventful; the wound of the knee healed by primary

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union. Follow-up at six months, the flexion of the knee was 100° and the extension 180° .

CASE II.—(C. J.) Colored male, aged twenty-three years, was admitted to the Surgical Service of the Harlem Hospital November 25, 1931, with the history of pain and swelling of the left knee of two years' duration. Onset in November, 1929, when he first noticed slight stiffness in the left knee and noticed that both flexion and extension were slightly limited. At that time he paid little attention to the condition, thinking it would soon pass away. He does not recall having injured the knee at any time. Three weeks before coming to the hospital, the knee-joint became quite painful and swelling was more pronounced.

Past History.—Negative, and family history is irrelevant. No other member of his family has ever had any similar affliction.

He was a well-developed man whose physical condition was entirely negative except for the local surgical condition in the left knee. Left knee-joint was larger in circumference than the right knee. Flexion present to 90° , and extension to 135° . There was fluid within the knee-joint as evidenced by the eliciting of the patella click and the prominence of the quadriceps bursa.

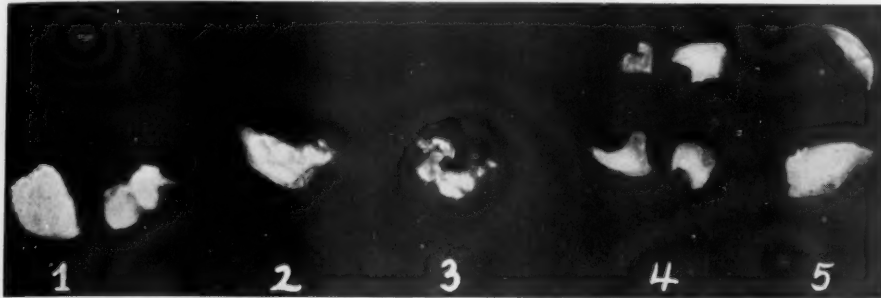


FIG. 10.—(C. J.) Fragments removed from knee-joint. (1 and 2) Plaque from the articular surface of femoral condyle. (3) Curettings from the excavated area of the femoral condyle. (4 and 5) Articular cartilage surrounding the excavated area on the femoral condyle.

Radiograph.—Examination of the left knee-joint showed destruction of the lateral portion of the articular surface of the internal condyle of the femur. The erosion appeared adjacent to the intercondyloid notch of the femur. In addition, there were loose bodies within the knee-joint and synovial thickening was present.

Diagnosis.—Loose bodies within joint due to osteochondritis dissecans involving the femoral condyle.

Operation.—(November 27, 1931.) A medial parapatellar incision seven inches in length was made. When the joint capsule was opened a moderate amount of fluid exuded. On the posterior surface of the internal condyle of the femur an area about the size of a twenty-five-cent piece was seen completely denuded of cartilage. At the same time the loose fragment of cartilage which had separated from that area was seen lying free in the joint and was removed. The entire synovial membrane appeared red and injected. The denuded area on the inferior surface of the condyle of the femur was curetted and the cartilage excised for about one-third of an inch about this area. All bleeding points were secured and the joint flushed with sterile saline. The joint capsule was closed. Gross specimens shown in Fig. 10.

Post-operative Course.—Satisfactory and entirely uneventful. Complete extension is present in spite of some quadriceps atrophy.

Follow-up Note.—(February 1, 1932.) Stated that the patient is walking without pain or discomfort and motion is practically normal except for some slight limitation in flexion which at this time is about 110° .

CASE III.—(J. N.) A well-developed and well-nourished colored male of thirty-

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nine was admitted to the Surgical Service of the Harlem Hospital October 29, 1931, with the complaint of weakness in the left knee-joint of three months' duration. For this period immediately preceding admission he states that his left knee has been slightly swollen and does not stand up under any strain as well as his right knee. There has been no locking of the knee-joint but flexion and extension have been limited to a slight degree sufficient to cause him to limp when walking.

Past History.—Negative except for pneumonia.

Physical examination negative except for the left knee-joint which is swollen. There is complete limitation of flexion and extension.

Laboratory Data.—Negative.

Radiograph shows an irregularity of the articular cartilage of the right internal femoral condyle on its internal aspect in the region of the intercondyloid notch. There is also present a circular calcific body about 1 centimetre in diameter. Fluid is present within the joint and a synovitis exists.

November 1, 1931, the knee-joint was opened by a seven-inch medial parapatellar incision. When the capsule was incised about 200 cubic centimetres of straw-colored fluid were evacuated from cavity of the joint. An osseocartilaginous mass was with-

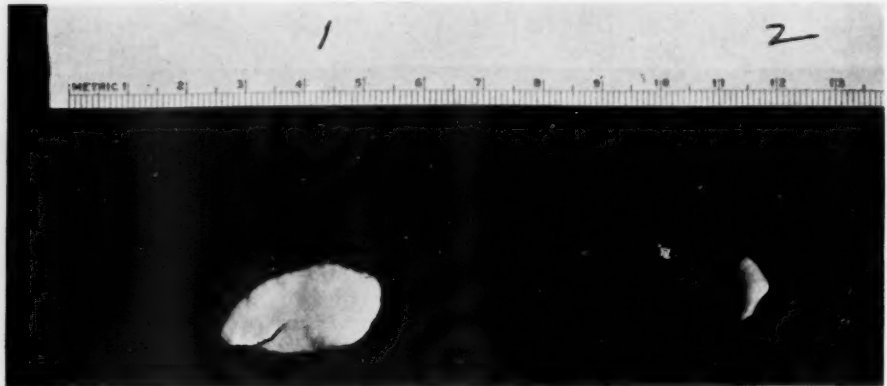


FIG. 11.—(J. N.) Fragments removed from knee-joint. (1 and 2) Fragments removed from the articular surface of the femoral condyle.

drawn. The mass was about three-quarters of an inch to one inch long and one-half inch wide. This was found to have sequestered from the external aspect of the medial condyle in the region of the intercondyloid notch where an excavation was present. The area was curetted and a red-gray granulation tissue removed and sent to the laboratory for culture and microscopical examination. Another similar mass of similar characteristics was withdrawn. The joint was closed tightly with interrupted mattress sutures. Patella was replaced and the skin wound sutured with interrupted silk.

Pathological Report.—Gross specimens shown in Fig. 11. Specimen consists of six irregular-shaped fragments, two of which are about one inch in length and the others about one-quarter inch in diameter. The specimens are nodular, firm and some of them exhibit processes which appear to be dendritic in shape. Consistency is markedly firm and on cut section shows hæmorrhagic areas surrounded by white fibrous tissue. Examination discloses loose connective tissue which in some areas is quite vascular. In other areas it gives the appearance of a keloid. There is no evidence of tuberculosis or other specific inflammatory condition. The post-operative course was uneventful and entirely satisfactory. Thirteen months after operation X-rays demonstrate no abnormalities. Patient is symptom-free.

CASE IV.—(A. S.) Colored male, aged twenty, was admitted to the Surgical Service of the Harlem Hospital December 13, 1931, on account of pain, swelling and

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inability to flex or extend right knee of one week's duration. Eight months ago he fell from a height while working and landed on the heel of his right foot. At this time he states that "something caught" in his knee-joint which loosened up after a few minutes. This sensation had occurred about every two weeks since. One week ago his knee became quite swollen.

Physical examination negative except for the local condition in the right knee which is markedly enlarged and distended by fluid. Flexion or extension causes marked distress and for that reason the extremity is held rigidly extended. December 15, 1931, the right knee-joint was aspirated and fifty cubic centimetres of bloody fluid obtained. A median parapatellar incision was made extending about three inches above and below the mid-point of the patella. The joint capsule was seen to be bluish in color, indicating the presence of more sanguineous fluid within the joint. On opening the knee-joint about six ounces of bloody joint fluid gushed forth. When the articular surface of the femur was brought into view the medial condyle presented a characteristic excavation with

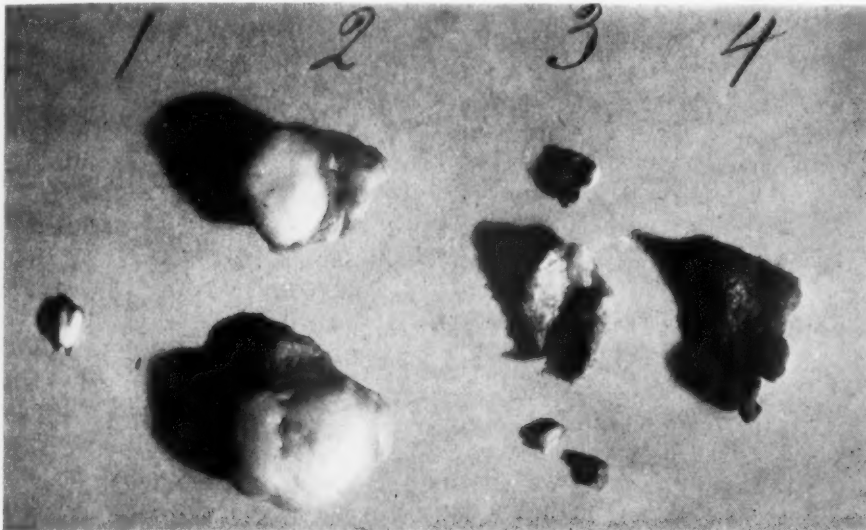


FIG. 12.—(A. S.) Fragments removed from the knee-joint. (1) Articular cartilage from area surrounding the excavation on the femoral condyle. (2) Plaques from the articular surface of the femoral condyle. (3) Curettings from the excavated area of the femoral condyle. (4) Hypertrophied villus removed from the joint.

the two fragments (Figs. 12 and 13) which had previously been seen in the X-ray picture lying in this crater. The depression was lined with a reddish-gray granulation tissue. The fragments, which were held by the thinnest pedicle, were removed. The entire synovial membrane presented the appearance of a chronic hypertrophic synovitis and was stained yellow from the sanguineous joint fluid. No other fragments were found in the knee-joint but one hypertrophied villus was removed for microscopical examination. Following the removal of the fragments mentioned above the excavated area was curetted. All bleeding points were secured and the joint capsule closed. The post-operative course was uneventful and entirely satisfactory.

One year later he was symptom-free and has normal range of knee movements which are unrestricted. X-rays show no loose bodies in knee-joint.

CASE V.—(G. M.) A colored male of thirty-one years was admitted to the Surgical Service of the Harlem Hospital March 22, 1932, with the complaint of pain and weakness in the left knee-joint of two months' duration. He states that eighteen months ago he fell and struck his left knee but noticed no untoward effect other than some slight intermittent pain which would occur at irregular intervals. This pain in the left

knee has become more persistent during the past two months preceding admission and for the past two weeks has been especially troublesome. He has never had any locking of the knee-joint but flexion and extension are now painful and are relieved only by keeping the extremity at rest and fully extended.

Radiograph of the left knee shows a protuberance in the region of the medial epicondyle of the femur near the intercondylar notch which is suggestive of an osteochondritis dissecans.

March 24, 1932, the knee was opened by a six-inch medial parapatellar incision. Prior to the opening of the capsule, the knee-joint was aspirated and about 100 cubic centimetres of dark yellow joint fluid obtained. On opening the knee-joint the entire synovia was seen to be reddened and the villi were hypertrophied. On the internal aspect of the medial condyle a typical loose body characteristic of the disease was found. It had not quite separated from the articular cartilage and for that reason was removed with sharp dissection. The cartilage surrounding the excavation was examined and

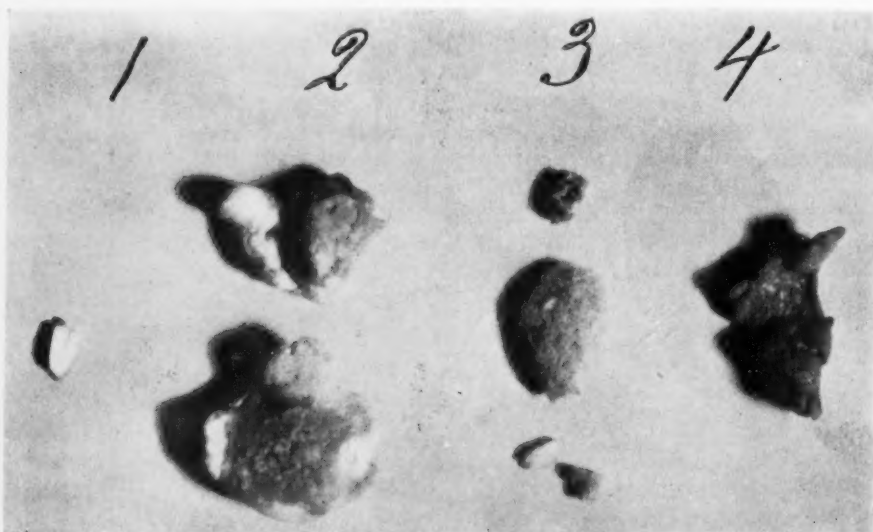


FIG. 13.—(A. S.) Fragments removed from the knee-joint. Shows reverse side of fragments removed from the femoral condyle.

found to be slightly undermined. In addition, one of the inflamed hypertrophied villi was also removed. The joint was then closed. The post-operative course was entirely satisfactory and uneventful.

Examination six months later shows the patient to be without symptoms, with motion in the knee unrestricted. The incisional scar is painless and he is able to walk about and perform his regular duties.

CASE VI.—White male of fifty-two years was admitted to the Surgical Service of the Harlem Hospital May 23, 1932, with the history of having been thrown from a horse twenty-five years before (1907), and having suffered an injury to his right knee. The condition in the knee improved with local treatments but he was never without slight pain and disability. He was told at that time that he had a "loose piece" of bone in his knee-joint but refused operation. For the past eight months preceding his admission his knee has been swollen and motion has been limited. At the present time he is able to palpate a loose body within the knee-joint and move it from side to side in the quadriceps bursa.

The right knee is markedly enlarged. A movable bony mass may be felt within the quadriceps bursa. Extension present to 120° and flexion to 90°.

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Radiograph shows a loose calcific lamellated body about three and a half centimetres in length present in the quadriceps bursa. In addition, a small niche is present on the medial condyle of the femur just medial to the intercondyloid notch.

May 27, 1932, the knee-joint was opened by a median parapatellar incision about seven inches in length. The loose body which had been seen on X-ray examination was found in the quadriceps bursa and was removed. It measured two inches by one and a half inches by three-quarters of an inch in thickness. The entire synovial membrane of the knee-joint was dark brown and sanguineous in color and seemed to be the site of a traumatic hypertrophic villous synovitis. Examination of the condyles of the femur revealed an eroded area on the inner aspect of the medial condyle. The cartilage of this area was eroded, of a different color, being more yellow, and less firm in consistency. Undoubtedly, this was the site from which the original loose body had been extruded at the time of the trauma twenty-five years ago.

The post-operative course was entirely uneventful.

Five months later the patient is symptom-free and is walking about with range of motion as follows: Extension 180° and flexion 100° . There is no pain in the incisional scar.

CASE VII.—A colored male of seventeen years was admitted to the Surgical Service of the Harlem Hospital October 28, 1932, with the history of pain, swelling and inability to move the right knee-joint of one day's duration. On the day preceding admission he was tackled while playing football and suffered injury to the right knee. The knee-joint is painful and swollen and extension and flexion are restricted.

Radiograph shows a loose body within the knee-joint, medial to the internal condyle of femur. An arthrotomy was done with removal of fragment which had become sequestered from the posterior surface of the patella. The post-operative course was uneventful.

CASE VIII.—A white male of forty-five years was admitted to the Orthopedic Clinic of the Harlem Hospital with the complaint of pain and swelling of the right elbow-joint. Onset followed a blow received four months previously.

Examination revealed a prominence over the radiohumeral bursa and limitation of flexion and extension of the forearm.

Radiograph revealed a loose body in the right joint sequestered from the capitellum of the humerus. He was advised to have an arthrotomy and removal of the loose body but refused. He was referred to the Department of Physiotherapy where he has been receiving baking of the elbow with some symptomatic relief and is being observed at the present time.

CASE IX.—A colored male of twenty-eight years was admitted to the Orthopedic Clinic of the Harlem Hospital November 10, 1932, with the complaint of pain and swelling of the right knee-joint of three months' duration. Onset of disability followed a fall on the knee and has become increasingly more pronounced.

Examination reveals swelling of the right knee-joint and limitation of flexion to 90° and extension present to only 135° .

Radiograph demonstrates an erosion and the presence of a sequestering calcific body on the medial condyle of the femur in the region of the intercondyloid notch. The patient was advised to enter the hospital for arthrotomy and removal of fragments but refused. He was referred to the Physiotherapy Department where baking was administered with slight symptomatic relief.

CASE X.—A white male of thirty years was admitted to the Orthopedic Clinic of the Harlem Hospital August 10, 1932, with a six-months' history of pain and swelling of the right elbow-joint.

Examination revealed a prominence over the radiohumeral bursa and limitation of flexion and extension of the forearm.

Radiograph revealed a loose body in the right elbow-joint sequestered from the capitellum of the humerus. He was advised to have an arthrotomy and removal of

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the loose body but refused. He was referred to the Department of Physiotherapy where he has been receiving baking of the elbow with some symptomatic relief and is being observed at the present time.

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SOLITARY BONE CYST*

THE LOCALIZED FORM OF OSTEITIS FIBROSA CYSTICA

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AMONG the less common diseases of the skeletal system, bone cyst, *i.e.*, the localized form of osteitis fibrosa, is of particular interest and importance. Since the more general use of radiographic examination for patients complaining of symptoms in the extremities, this condition is now being recognized much more frequently. Its differentiation, however, from other pathological conditions of bone is important, since a correct diagnosis is essential in order that treatment be carried out to the best advantage and an accurate prognosis given.

It is the purpose of this paper to discuss the etiology, the diagnosis, the treatment and the prognosis, based upon a study of the literature, and, in particular, upon a series of twenty-six cases personally observed at the Hospital for Ruptured and Crippled, Memorial Hospital and Lincoln Hospital.

Historical.—Bone cyst was first recognized by Virchow in 1876, who described a case found at autopsy in the humerus of a patient fifty-four years old. As early as 1879, Sonnenberg recorded a case of traumatic origin in an adolescent, and Schlange, in 1887, described a similar case. The specimens of both of these cases were examined by von Recklinghausen, who in 1891 described in detail the fibrocystic degeneration in the long bones to which the term "von Recklinghausen's disease" has been given.

Heineke was apparently the first one to study this condition by means of the Röntgen-ray (1903).

Pfeifer, in 1907, contributed to the histological, bacteriological and radiographic study. From this time on the condition has attracted increasing attention and during the last decade a large number of contributions have appeared, among which may be mentioned those of Bloodgood, Platau, Silver, Sisk and especially Geschickter and Copeland.

Description of the Disease.—Solitary bone cyst is a distinct clinical entity which has certain well-recognized characteristics. It has its onset during the period of childhood and adolescence, which is also the period of greatest activity of bone growth. It has a predilection for the metaphyseal region of certain long bones, most noteworthy of which are the upper extremities of the femur, humerus and tibia. Symptoms are usually extremely mild and it is for this reason that about half of the cases are not suspected prior to the occurrence of a pathological fracture. Moreover, in cases without fracture the duration of symptoms from onset to first admission is long, averaging well over two years and in some cases (latent bone cysts) it may be from five to ten or more years.

* Read before the New York Surgical Society, April 26, 1933.

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Physical examination alone rarely furnishes a clue to the underlying condition (unless fracture has previously occurred) and the diagnosis is seldom established until radiographs have been made. The area of localized bone destruction close to the epiphysis, but always on the diaphyseal side, with a circumscribed expanded cortex and often some trabeculation, makes a characteristic radiographic picture, which is usually easily recognized.

Intermediate Forms.—There have been described cystic processes in the long bones which partake somewhat of the nature of both giant-cell tumor and bone cyst. Tavernier reports in detail three cases personally observed which he terms "a bone disease intermediary between giant-cell tumor and bone cyst." Geschickter and Copeland describe what they term giant-cell variants of bone cyst and state that their chief distinctive feature lies in

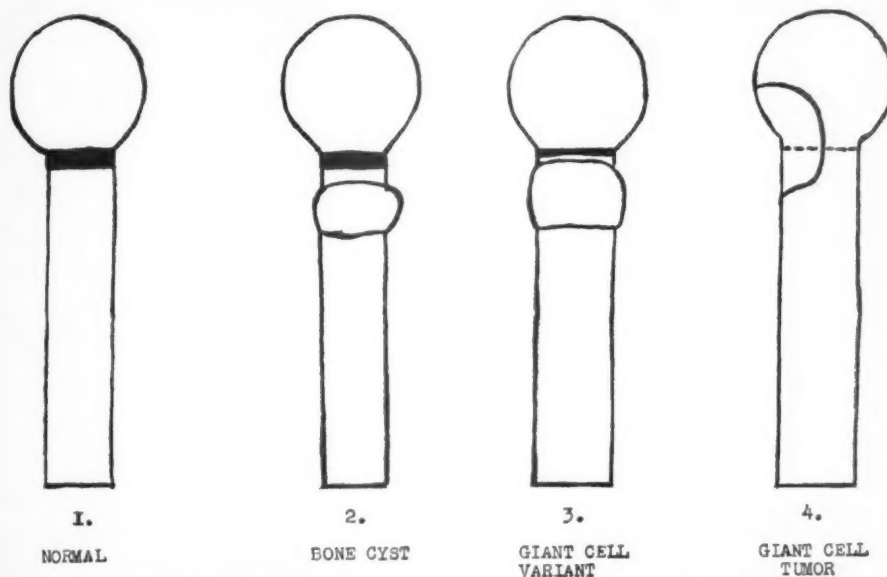


FIG. 1.—Schematic drawing showing location, in respect to epiphyseal line of the involved area in (2) bone cyst, (3) giant-cell variant of bone cyst, and (4) giant-cell tumor.

Note especially the proximity of process to epiphyseal line in (3), also that epiphysis is about to unite. And in (4) that it involves the head rather than the shaft side of the epiphyseal line (now united) though extending across to involve metaphyseal area somewhat.

their shorter duration of symptoms (six months or less). They also discuss a form which they have called polycystic osteitis fibrosa. However, it seems unnecessary to differentiate this group from the remainder of the solitary bone cysts except upon radiographic appearance—its clinical significance is not evident. These intermediate forms are of interest chiefly because they provide further presumptive evidence of the close association of giant-cell tumor and bone cyst.

It is our belief that the giant-cell variant of bone cyst occupies an intermediate position between simple bone cyst and giant-cell tumor. (Fig. 1.) It occurs more nearly at the time of union of the epiphysis; whereas bone cyst begins at an earlier age and giant-cell tumor after the epiphyseal union has taken place. Its clinical course, however, runs more closely parallel to

that of the simple cyst than that of the giant-cell tumor. It is more of a regressive than a progressive osteoclastasia.

Expressed in another way, it may be said that in general the true bone cyst has its inception during childhood, the giant-cell variant during adolescence, and the giant-cell tumor after skeletal growth has been attained.

In bone cyst the entire course of the disease is indicative of the essentially benign nature of the process. It has a tendency to increase in size, but very slowly, to heal spontaneously, and to be aided in this healing process as a result of a pathological fracture. It yields to conservative surgery. It is always surrounded by a shell of cortical bone, which is never completely eroded and remains intact unless there has been a fracture. Following fracture, which may be caused by the most trivial of injuries, the rapid formation of callus and progressive healing with firm bony union is the rule. Fracture does not always result in complete healing of the cyst and at a later date a second fracture may occur.

Classification of Bone Cyst.—The classification suggested by Bloodgood in 1910 has been followed by most subsequent writers on this subject. It is as follows:

- (1) Single cyst, bony shell, no connective-tissue lining.
- (2) Cysts with a definite connective-tissue lining varying as a rule from one to two mm.
- (3) A small cyst, or cysts, in a solid mass of osteitis fibrosa.
- (4) No cyst, but bone shell filled with a solid mass of osteitis fibrosa.
- (5) Multilocular cysts.

This classification seems to be based mainly on the gross pathology as found at operation. The clinical significance of these separate groups is not apparent. They represent different stages in a pathological process, which probably begins with a subcortical hæmorrhage followed in turn by localized bone destruction, a zone of vascular granulation tissue, in which osteoclasts (giant cells) are found, fibrosis and, later, cyst formation. Ultimate healing is slow, a fact probably due to the difficulty with which a dead space is obliterated when its walls are rigid.

Etiology.—As yet, no agreement has been reached as to the etiology of simple bone cyst. Several theories may be mentioned and each has its proponents, and against each there are weighty arguments. Some of these theories may be mentioned and briefly discussed.

(1) *Theory of Trauma. Traumatic Hematoma.*—This theory has attracted a number of writers. Jenckel, after a study of eight cases, believed bone cyst is often caused by hæmorrhage. Lang concluded that a traumatic hematoma is the first factor in the development of a solitary cyst. Bencke also attempted to prove the theory that a hæmorrhage into the bone, which for some reason is not organized or absorbed, is the cause of cyst formation. Anshitz considered trauma an important etiological factor; Mauclair and Burnier regarded it as the most frequent cause. Platau, and Mouchet and Le Gac opposed the theory of trauma, the latter on the ground that all their cases showed well-developed cysts in a very short period after the trauma.

(2) *Theory of Inflammation. Infection.* Bloodgood early adopted the view that

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osteitis fibrosa is primarily an inflammatory condition, in which the medullary portion of the bone is replaced by connective tissue. Hamberlin believed that osteitis fibrosa is a circumscribed endosteal fibrogenous osteomatosis or an osteoplastic metaplasia of the endosteum with secondary fibrosis of the medulla, associated with giant-cell collections and degenerations of connective tissue secondary to these. He conceived that the process might be the result of a low-grade infection.

Pfeifer, reporting on a histological, bacteriological and radiographical study of four cases, concluded that the circumscribed bone cysts are nothing but softening centers of inflammatory tissue in bone marrow.

(3) *Theory of Metabolic Origin. Faulty Calcium Metabolism.*—In their effort to determine the cause of the formation of bone cyst, some writers have been impelled by the evidence of malacia to attempt to show a relationship between bone cyst and Paget's disease in the adult, and rickets in children. Yet, as Sisk has stated, despite some similarity in radiographical appearance, and a fundamental change in calcium metabolism common to all of these conditions, there is still lacking plausible evidence linking them together. He was probably referring to the multiple form of osteitis fibrosa, or von Recklinghausen's disease, which is a distinct clinical entity not to be confused with solitary bone cyst. We believe that metabolic disturbances play no part in the etiology of bone cyst. Fujii considers osteitis fibrosa cystica as totally distinct from and independent of osteomalacia.

(4) *Theory of Abnormal Hyperplasia of Osteoclasts. Progressive Osteoclastasia.*—This theory, advanced by Geschickter and Copeland, concludes that bone cyst and giant-cell tumor are results of an abnormal hyperplasia of osteoclasts. This is preceded by a normal stage in which osteoclastic proliferation is taking place as a step in the histogenesis of bone that is developed from preformed cartilage. They suggest the term progressive osteoclastasia for the process in giant-cell tumor, and regressive osteoclastasia for the process in bone cysts. They support their view by showing that wherever giant-cell tumors are found they are situated where osteogenesis in cartilage is possible. Their theory invokes that of trauma in that it depends upon a traumatized subcortical area in which there has been an interruption of the blood supply from the periosteum to the cortical bone with the development of a subperiosteal hematoma. The medullary circulation in the region of the epiphysis must, by increased activity and establishment of new channels around the injured area, undertake the function of repair. But this increased activity occurs during a period when cortical bone, cut off from its circulation, is undergoing necrosis. Thus an unequal balance is struck between bone destruction (osteoclasts) and reparative new bone formation that would follow from reactive cortex if the circulation were intact.

Summary of Etiology.—While there is no single accepted theory to account for the development of solitary bone cyst, one can point out the fact that each of those mentioned lacks conclusive evidence to support it and is open to objections. Those who believe trauma is responsible do not explain those cases which give an insidious history unassociated with a definite injury. And while trauma is undoubtedly a factor of major importance in calling attention to an abnormal condition in the bone, it is usually because it produces at least a partial fracture and immediate radiographs have shown the presence of a cyst already well developed. I have not been able to find a case which would tend, by the following sequence of events, to prove the etiological importance of trauma, *i.e.*, history of injury; radiographs made at once showing normal bone; later persistence of symptoms calling for further radiographs which then showed the presence of a cyst. It seems clear, then, that trauma is the frequent exciting factor in the recognition of a cyst, but by no means certain that it initiates it.

There is little scientific basis for the assumption that a calcium deficiency is the underlying cause. In five cases blood-calcium determinations were made and were within normal limits in each instance. In none of these cases has any other bone later

become involved in the cystic process. No dietary deficiencies have been established as existent in cases in this group.

As for the inflammatory theory, the presence of an infectious or toxic agent has never been established. Bacteriological studies have been unsuccessful in obtaining evidence of a causative organism. Yet the histology and the clinical course point rather clearly to the supposition that a low-grade inflammatory process is responsible for the development of bone cyst. However, the picture differs in most cases from that of a Brodie's abscess which is known to be due to a low-grade central osteomyelitis. It more closely resembles a healing process in its varying stages. But what evokes the need for bone repair?

The conception of Geschickter and Copeland—abnormal hyperplasia of osteoclasts—seems at present to rest upon the most secure foundation of facts and has the added attraction that it applies equally well to the development of bone cyst and of giant-cell tumor. It is based upon the known facts of blood supply and of bone repair and bone absorption by osteoclasts. It does not explain those cases in which there has been no trauma, nor does it take into account the fact that though most children undoubtedly sustain many injuries of a minor nature to the growing ends of their long bones, still bone cyst is a relatively uncommon finding. The same may be said for the young adult in relation to giant-cell tumor. Nor does their theory account for the relative rarity of bone cyst in the lower end of the femur, a site in which giant-cell tumor appears most frequently.

Symptoms and Physical Signs.—The absence of pronounced symptoms in uncomplicated cases of solitary bone cyst is one of the features of this condition.

Pain is the commonest complaint, but is often so trivial and intermittent as to arouse no suspicions on the part of the patient and it is for this reason that a long interval between the onset and first visit to the clinic is the rule rather than the exception. The pain may be present only after prolonged function or slight strain.

Pathological fracture is frequently the first symptom. It was obviously the initial symptom in ten of the seventeen cases in this series in which the history is definite. The occurrence, in a child, of a fracture of a long bone near a joint from trivial injury should arouse immediate suspicion of the presence of a bone cyst.

Swelling is not a prominent symptom and is usually not detectable unless the cyst lies in a relatively exposed position, such as the lower end of the radius, ulna or upper tibia.

Disability is mentioned in the histories of only two of the seventeen cases prior to fracture; it is obviously complained of by all the patients in whom fracture has occurred, but rapidly disappears with healing of the fracture.

Radiographic Appearance.—The bone cyst has certain well-defined characteristic röntgenographic features. Among these may be mentioned the metaphyseal location, the decided thinning of the cortex with expansion, usually slight in degree, and with intact shell unless a pathological fracture has occurred. In cases that have had one or more fractures the subsequent healing frequently is associated with dense new bone formation, which may traverse the cystic area in one or more trabeculations. The examination of a

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considerable number of typical films of solitary bone cyst will enable one to recognize this condition, when it is subsequently encountered, whereas it is difficult to describe it. It may simulate in appearance a giant-cell tumor, but it occurs in younger individuals and almost always before the adjacent epiphysis has united. It should be especially emphasized that bone cysts commence in the metaphysis on the diaphyseal side of the epiphyseal line, whereas giant-cell tumors begin in the epiphysis. Latent bone cysts (recognized in later life) may be found in the middle third of the shaft.

Pathology.—Little can be added to the discussion of this phase of bone cyst in the monograph by Geschickter and Copeland; so that no detailed consideration will be made of it here.

It is our belief that bone cyst and giant-cell tumor are closely connected conditions, which have more than mere radiographic and histological similarity to suggest this relationship. We have operated upon several typical bone cysts in which the microscopical appearance of many areas was quite typical of osteitis fibrosa, but in other areas the structure seen in typical examples of giant-cell tumor was found. It would make considerable difference which of these areas was found, if the diagnosis were allowed to rest solely on histological grounds. This thought is not new, apparently, for John B. Murphy, as early as 1913, remarked that, "in fibrocystic disease the diagnosis may as well be made by the X-ray examination as by the microscope. The surgeon who depends upon frozen sections for diagnosis in bone tumors of central origin will come to grief."

We believe that the essential differences between bone cyst and giant-cell tumor lie in the age of the individual and in the location of the lesion. The phase of bone destruction in the epiphysis meets with less resistance and evokes a less aggressive healing phase (defensive reaction of cortical bone) than it does in the metaphysis. It is more active in the young adult than in the child. Whether this is due to the fact that there is in the growing child a more active bone reparative function than is present in the young adult, or solely to the fact that before the epiphyses have united the lesion attacks the metaphysis and is prevented from involving the epiphysis by the presence of the cartilage layer at the epiphyseal line, is a matter of speculation. Whatever the explanation, it is a fact that in the metaphysis the arrested lesion, bone cyst, occurs; whereas in the epiphysis the progressive, or unchecked lesion, giant-cell tumor is found.

Age.—Of the twenty-six cases in this series, nineteen were under twenty years of age at the time of first admission to the clinic. The youngest was a boy of four, the oldest a woman of forty-one. The average age was 15.9 years. If the oldest patient be excluded (and her symptoms actually began with fracture twenty-three years prior to admission), the average age of the rest would be 14.9 years.

Sex.—There were fifteen males and eleven females. Most writers agree that the condition is more common in males. This might be explained on the greater likelihood of injury to the bone in the growing boy.

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Trauma.—Onset with symptoms of pathological fracture, in most instances after trivial injury, was noted in seventeen of the twenty-six cases; there were four cases in which trauma preceded the onset of symptoms by a considerable period. In two cases without fracture radiograph taken two days after the injury showed the presence of a cyst. In eight of the patients no history of injury could be elicited.

Duration of Symptoms.—Of the twenty-six cases, four sought treatment

SUMMARY: 26 CASES OF BONE CYST.

No.	Case	Age	Sex	Date.	Site.	third	Trauma	Fracture	Complaint	Duration	Treatment	Result
1.	P.C.	22.	M.	6/29/32.	L. Humerus.	upper	yes.	0	swelling	2 years	Cur	Good.
2.	P.T.	9.	M.	2/ 7/33.	L. Humerus.	upper	yes.	at onset	pain	6 days	Fr	#
3.	L.D.	23.	F.	11/22/32.	L. Phalanx.	middle	yes.	0	pain	5 years	Cur	Good.
4.	F.F.	14.	M.	12/16/24.	R. Femur.	upper	yes.	at onset	pain	1 day	Fr+Cur	Good.
5.	A.S.	14.	M.	2/24/30.	L. Radius.	lower	yes.	later	swelling	1 year	Fr+Irr	Good.
6.	C.D.	15.	M.	3/25/20.	L. Humerus.	upper	0	at onset	pain	6 weeks	Irr+Cur	Good.
7.	H.F.	19.	F.	10/30/25.	L. Femur.	upper	0	0	pain	5 months	Irr	Good.
8.	M.L.	10.	M.	12/ 2/31.	L. Femur.	upper	0	0	limp	3 months	Fr+Cur	Good.
9.	H.Q.	20.	F.	10/28/29.	R. Humerus.	lower	yes	at onset	pain	1 day	Fr+Irr	Good.
10.	R.H.	5.	M.	6/ 9/31.	R. Humerus.	upper	yes	at onset	pain	3 weeks	Fr	Good.
11.	A.C.	27.	F.	9/13/30.	L. Humerus.	middle	0	0	pain	4 years	Cur	Good.
12.	L.L.	13.	F.	11/ 4/22.	R. Ulna.	lower	yes	0	pain	10 month	Cur	Good.
13.	J.M.	8.	M.	6/19/24.	R. Femur.	upper	yes	later	pain	2 years	Irr+Fr*	Good.
14.	J.F.	16.	M.	9/ 7/26.	R. Radius.	lower	0	0	pain	2 years	Irr	Fair.
15.	W.M.	18.	M.	5/13/32.	R. Fibula.	upper	0	at onset	pain	1 day	Fr+Cur	lost
16.	S.R.	6.	F.	9/11/25.	L. Femur.	upper	yes	at onset	pain	5 days	Cur	Good.
17.	G.B.	9.	F.	11/14/28.	L. Femur.	lower	yes	0	pain	2 days	0	lost
18.	M.C.	10.	F.	12/10/31.	R. Tibia. R. Fibula.	lower upper	yes	at onset	pain	2 days	Fr+Cur	Good.
19.	A.H.	18.	M.	11/ 9/31.	R. Humerus.	upper	yes	later	pain	2 weeks	Fr+Cur	Good.
20.	F.J.	35.	M.	4/29/31.	L. Rib 7.	middle	yes	at onset	pain	2 days	Irr	Fair.
21.	B.W.	41.	F.	4/10/32.	R. Femur.	middle	yes	at onset	pain	23 years	Cur+Gr	Fair.
22.	R.C.	22.	F.	8/30/30.	L. Femur.	upper	0	0	pain	2 years	Irr	Good.
23.	S.B.	13.	M.	1/25/28.	R. Humerus.	upper	yes	later	pain	6 years	Fr	Good.
24.	H.G.	13.	M.	1/ 8/26.	L. Femur.	upper	0	later	pain	1½ years	Fr	Good.
25.	F.F.	9.	F.	3/11/30.	R. Humerus.	middle	yes	at onset	pain	1 day	Cur+Gr	Good.
26.	L.F.	4.	M.	1/27/30.	R. Femur.	upper	yes	later	pain	6 months	Cur+Gr	Good.

Too recent to judge result.

* Treated by irradiation, later for pathological fracture, then by osteotomy to correct deformity.

TREATMENT: Fr=for fracture. Cur=curettage. Irr=irradiation. Gr=bone graft.

with the appearance of the first symptom and five more were admitted to the clinic within a week after the first symptom. In seven cases the interval was between one week and one year, and in ten cases from one to twenty-one years. Thus it is apparent that the majority of patients seek medical attention early, because of fracture, or else after the lapse of at least a year because the symptoms are so mild and cause so little disability.

Bone Involved.—The femur was the affected bone in ten cases, the humerus in nine, the radius and fibula twice each, and the tibia, ulna, rib, and phalanx of finger but once each. The upper end of the femur, humerus

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and fibula was the site most often affected, while in the ulna and radius cases the lower end only was involved. The middle of the shaft of the humerus and the femur was the site of the cyst in one instance each, but it seemed to us that the ages of the patients, twenty-seven and forty-one, made it likely that the growth of bone had progressively shifted the cyst towards the centre of the shaft.

Treatment of Bone Cyst.—The treatment of solitary bone cyst is surgical. There is a striking agreement upon this point among the many who have made important contributions to our knowledge of this disease. Among these may be mentioned von Haberer, Hoffmeister, Schlang, Tavernier, Mouchet, Dujarier, Heitz-Boyer, Ombrédanne, Bloodgood, Sisk, Painter, and others. Sisk states, "in the treatment of osteitis fibrosa cystica the greatest economy of time is served by conservative surgery at the time the lesion is discovered. The uniform success obtained by surgery, with a comparatively short convalescence period, argues against long periods of watchful waiting." While all agree that conservative surgery is indicated, there is apparent a wide range of procedures that have been suggested, some of which cannot be regarded as conservative.

When a fracture has occurred in a previously unrecognized bone cyst, manipulation to obtain satisfactory position, if necessary, followed by immobilization during the healing period, is in most cases all that is necessary to obtain a satisfactory result. We know of no case in which union was not promptly attained. If fracture should fail to heal the cystic area, an operation could be done at a later date.

When recognized before a fracture has occurred, it would seem, on theoretical grounds at least, that the deliberate production of a fracture under anæsthetic with manipulation and immobilization was a justifiable procedure, as exemplified by those cases in which a satisfactory end-result followed a spontaneous fracture.

We recommend operative interference, which consists in exposing the involved area, cutting a large enough window to give access to the entire cavity and carefully curetting the entire contents down to cortical bone. The cavity should then be swabbed out with an escharotic, such as carbolic acid, alcohol, or zinc chloride saturated solution, followed by irrigation with normal saline solution. The rectangular segment of cortical bone removed in exposing the cyst may then be placed in the cavity as a graft, and the wound closed in layers without drainage. The practice of packing the cavity of a bone cyst (or a giant-cell tumor) is mentioned only to be condemned; most of the surgical catastrophes have been due to infection following this procedure. The cavity undoubtedly fills with blood clot into which osteoblasts later progress and form new bone. Unlike hematomas elsewhere, the blood clot in a bone cyst or giant-cell tumor cavity rarely becomes infected, if the wound is properly closed. When packing is used, infection is apt to occur. We seldom use bone chips or small osteoperiosteal grafts; rarely a massive bone graft may be necessary.

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X-ray therapy may be employed, but in our opinion the results are more uncertain and less satisfactory than those obtainable by surgery. One should also consider the possibility of damaging the growth centres by over-irradiation.

In this series of cases there was a wide variety of methods of treatment which can readily be ascribed to the fact that the cases were treated in three different hospitals.

Prognosis.—The prognosis for a satisfactory anatomical and functional result in bone cyst is good. The danger to life and limb should be non-existent. No case in this series of simple bone cyst required a mutilating operation and there was no mortality. Fracture seldom produces marked deformity. Healing of the fracture is prompt; there were no cases in this series of delayed union or non-union. Where fracture occurs repeatedly (in two of our cases twice), there is usually shortening as an end-result. In the upper extremity this may have little significance, but in the femur it may require the use of measures to compensate for this shortening. In weight-bearing bones, if the process is left unsupported for a considerable period and bending is permitted, the deformity may be of serious consequence from a functional standpoint, as illustrated in Case XIII.

Results.—The end-results are briefly summarized in the table below. Curettage, with or without additional procedures, was the method used in thirteen cases, with twelve good and one fair result. Treatment of the fracture only gave good results in the four cases so treated. Irradiation alone, or combined with other procedures, was used in eight instances with five good results, two fair, and one not traced.

Treatment	RESULTS			
	Good	Fair	Poor	Not Traced
1. No Treatment.....	0	0	0	1
2. Treatment of Fracture Only.....	4	0	0	0
3. Curettage Alone.....	5	0	0	0
4. Curettage After Fracture.....	5	0	0	0
5. Curettage plus Graft.....	2	1	0	0
6. Curettage plus Irradiation.....	1	0	0	0
7. Treatment of Fracture plus Irradiation.....	2	0	0	0
8. Irradiation Alone.....	2	1	0	1
9. Prolonged Irradiation—Later Fracture—Mal-union Requiring Osteotomy.....	0	1	0	0
Totals.....	21	3	0	2

CASE SUMMARIES

CASE I.—P. C., male, aged twenty-two, was admitted to Memorial Hospital June 29, 1932, with a history of having been struck on the upper left arm with a packing case two years previously. His only complaint was of a swelling in the region injured. Clinical diagnosis was healed bone cyst of the upper end of the left humerus; X-ray diagnosis was chondrosarcoma. While under observation he began to complain of pain in the affected region; so curettage was performed January 25, 1933, with pathological findings of

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chronic osteitis. When examined five weeks later the wound was well healed and the function of the arm was excellent.

CASE II.—P. T., aged nine, was admitted to Lincoln Hospital February 7, 1933, two days after he had injured his left arm, sustaining a pathological fracture through a bone cyst in the upper end of the left humerus as revealed by X-ray films. He was treated as for simple fracture and a good result is to be expected, though it is too early to make a positive statement.

CASE III.—L. D., female, aged twenty-three, was admitted to Lincoln Hospital November 22, 1932, with pain and swelling of the left middle finger persisting for five years following injury to the finger. X-ray films showed a bone cyst in the middle of the proximal phalanx. This was curetted and carbolyzed November 22, 1932, with an excellent result. The pathologist reported osteitis fibrosa cystica circumscripta.

CASE IV.—F. P., male, aged fourteen, was admitted to Lincoln Hospital December 16, 1924, because of pain in the hip occurring after a fall while at play in a gymnasium. X-ray film showed a fracture of the upper end of the femur through a bone cyst. He was treated as for simple fracture first and two months later curettage was performed. This was followed by wound infection, which subsided in a month, and a walking Thomas caliper was worn for six months. Following this he had an excellent anatomical and functional result.

CASE V.—A. S., male, aged fourteen, was admitted to Memorial Hospital February 24, 1930, with a history of injury to the wrist one year previously and a more severe injury nine months later, when X-rays were taken which showed a fracture through a cystic area in the lower end of the radius. A splint was applied and X-ray treatments were given. Four more X-ray treatments were given at Memorial Hospital and the splint was removed. An excellent result was secured and three years later no appreciable difference in the two wrists could be demonstrated.

CASE VI.—C. D., male, aged fifteen, was admitted to Memorial Hospital March 25, 1920. Six weeks previously he had sustained a fracture through a bone cyst in the upper end of the left humerus and the cyst had been curetted and the fracture set. Radium-pack treatments were given at Memorial Hospital after the wound had healed, and ten years later the patient was symptom-free and function of the arm was excellent.

CASE VII.—H. F., female, aged nineteen, was admitted to Memorial Hospital October 30, 1925, with a history of pain in the left thigh of five months' duration and difficulty in walking for one month. X-ray diagnosis was chondrosarcoma of the upper end of the shaft of the left femur. Clinical diagnosis was osteitis fibrosa cystica. X-ray and radium treatments were given for three months with prompt improvement and two years later clinical and X-ray evidence showed an excellent result.

CASE VIII.—M. L., male, aged ten, was admitted to the Hospital for Ruptured and Crippled December 2, 1931, with a history of a limp of three months' duration. X-ray films revealed a multilocular cyst in the upper end of the left femur. This was curetted and a plaster spica applied. The spica was removed nine weeks later and weight-bearing allowed. Six months later clinical and X-ray examination showed an excellent result. Pathological examination of the curetted material showed fibrous connective tissue.

CASE IX.—H. Q., female, aged twenty, was admitted to Memorial Hospital October 28, 1929. She had fallen on the stairs and struck her right elbow, sustaining a fracture of the humerus into the olecranon fossa. A splint was applied and in radiographs made two weeks later a cyst was observed at the site of fracture. Two X-ray treatments were given. There was good union of the fracture and rapid healing of the cyst, and the anatomical and functional result is excellent.

CASE X.—R. H., male, aged five, was admitted to Memorial Hospital June 9, 1931, three weeks after he had fractured his arm through a cystic area in the upper end of the right humerus. The arm had been put up in abduction in a plaster spica and no other form of treatment was employed. The fracture healed nicely and ten weeks after the injury the patient was symptom free and exhibited perfect function of the arm.

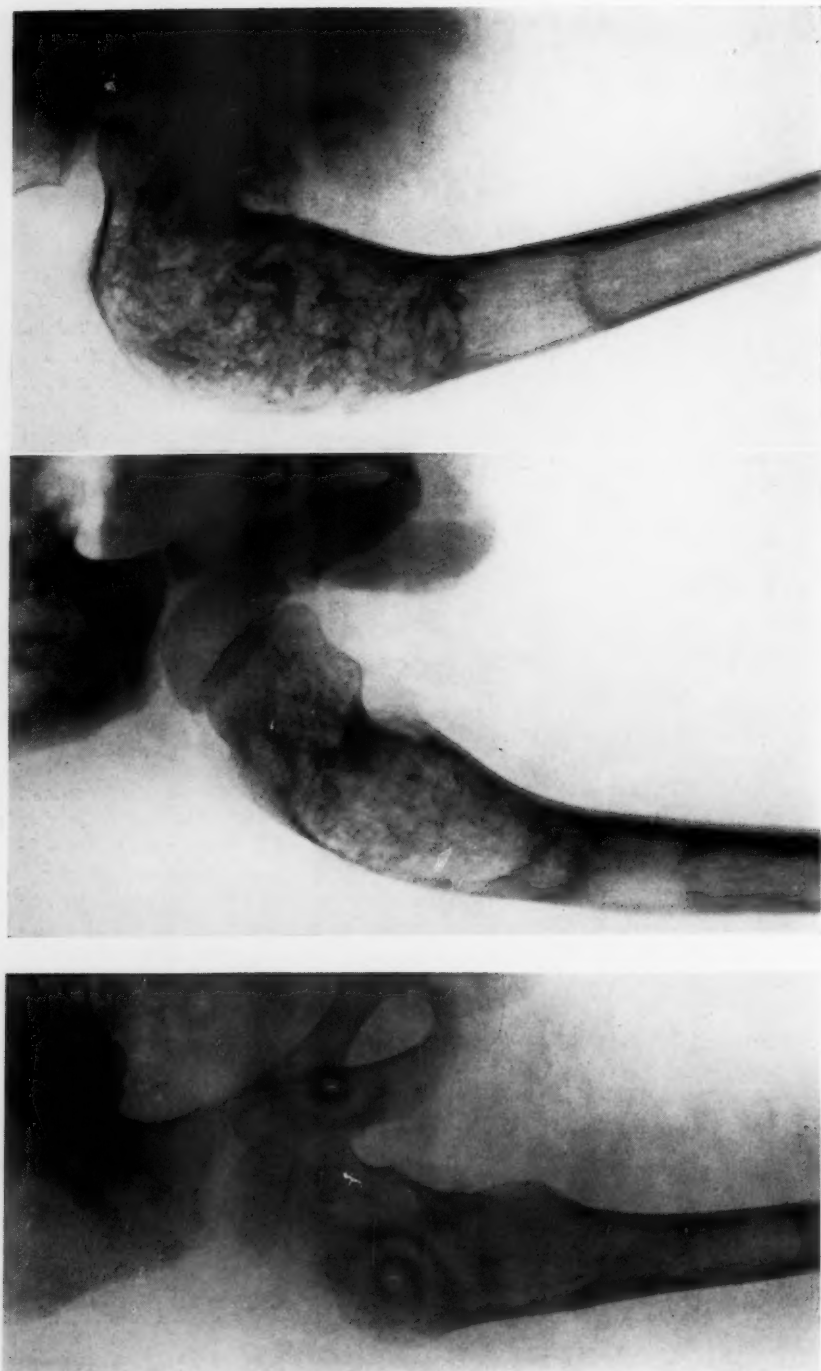


FIG. 2.

FIG. 2.—(Case XIII.) Bone cyst in upper femur—boy of eight years—showing condition at time of admission.

FIG. 3.

FIG. 3.—(Case XIII.) Showing condition three years later. X-ray therapy in the interval.

FIG. 4.

FIG. 4.—(Case XIII.) Shows degree of involvement, bending of upper shaft and neck with marked coxa vara. Film made five years after Fig. 1 and two years after Fig. 2.

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CASE XI.—A. C., female, aged twenty-seven, was admitted to the Hospital for Ruptured and Crippled September 13, 1930, with a history of a dull aching pain in the left arm. X-ray films revealed a cystic area in the middle of the shaft of the humerus. Curettage was performed. Pain was relieved, but ten months later there was evidence of renewed activity; so a second curettage was performed and was followed by complete healing and return to perfect function. Pathological report on the first operation was benign central chondroma, and on the second was chronic osteitis.

CASE XII.—L. L., female, aged thirteen, was admitted to the Hospital for Ruptured and Crippled November 4, 1932, with a history of injury to the wrist ten months previously, followed by persistent swelling and continued pain after a second injury six



FIG. 5.



FIG. 6.

FIG. 5.—(Case XIII.) Shows appearance one year later (six years after first admission). Lesion apparently healed but deformity and shortening marked. An osteotomy was later performed at the Hospital for Ruptured and Crippled.

FIG. 6.—(Case XIII.) End-result eleven years after first admission and three and a half years after osteotomy. Patient now aged eighteen. Shows shortening, restoration of neck and head in relation to shaft; also site of osteotomy performed for deformity.

months later. X-ray diagnosis was giant-cell tumor of the distal end of the ulna; clinical diagnosis was bone cyst. The area was curetted and followed by primary wound healing and rapid return to full function.

CASE XIII.—J. M., male, aged eight, was admitted to Memorial Hospital June 19, 1924. At the age of six he had been struck over the right thigh with a baseball and this was followed by a persistent limp, weakness of the leg and occasional pains in the thigh. Later an X-ray film was made and revealed a cystic area in the upper end of the femur. X-ray therapy was given in July, 1924, and again in October, 1927. In August, 1928, he fell and fractured his femur through the involved area. (Figs. 2, 3, and 4.) He was treated by means of a plaster spica, but there was marked deformity and shortening, necessitating an open operation for correction one year later. Recent examination shows

him free from pain, but he walks with a moderate limp and shows four inches of measured shortening in the affected limb. (Figs. 5 and 6.)

CASE XIV.—J. P., male, aged sixteen, was admitted to Memorial Hospital September 7, 1926, complaining of pain in the right wrist of two years' duration. Radiographs revealed a bone cyst in the distal end of the radius. One X-ray treatment was given and increase in the pain noted two weeks later. The patient did not return to the clinic and could not be traced.

CASE XV.—W. M., male, aged eighteen, was admitted to Memorial Hospital May 13, 1932. While picking up two five-gallon cans of oil he felt a sudden pain in his leg. X-ray films revealed a fracture through a bone cyst in the upper end of the right fibula.



FIG. 7.—(Case XV.) Healing of a bone cyst in which a spontaneous fracture was the first symptom. Curettage. Excellent anatomical, functional and economic result.

The cyst was curetted and a cast applied for nine days. There were no further symptoms and a year later function was normal. (Fig. 7.)

CASE XVI.—S. R., female, aged six, was admitted to Lincoln Hospital September 11, 1925, complaining of pain in the hip and inability to walk for the past five days following an injury to the hip. X-ray films showed a pathological fracture through a cyst in the upper end of the shaft of the left femur. This was curetted; the wound healed per primam and the patient was allowed to walk without crutches in two months. A year later anatomical and functional result was excellent.

CASE XVII.—G. B., female, aged nine, was admitted to Lincoln Hospital November 14, 1928. Two days previously she had twisted her knee and X-ray films, taken for possible fracture, revealed a bone cyst in the lower end of the left femur. Patient was kept in bed for two weeks and no other treatment was adopted. She was discharged symptom-free and has never returned for follow-up examination.

CASE XVIII.—M. C., female, aged ten, was admitted to Lincoln Hospital December 10, 1931. Two days before admission patient fell and injured her right ankle. X-ray films show a pathological fracture through a bone cyst in the lower end of the right tibia, and a small cystic area in the upper end of the right fibula. Skeletal films were taken and revealed no other cystic areas. The lesion in the right tibia was curetted and a plaster cast applied. Five weeks later she was discharged from the hospital without her cast and, when examined two months ago, had an excellent result.

CASE XIX.—A. H., male, aged eighteen, was admitted to Memorial Hospital November 9, 1931. Two months previously he had wrenched his shoulder. After the pain and swelling disappeared he again injured his shoulder with more severe symptoms of pain and disability, and X-ray films revealed a bone cyst in the upper end of the right humerus, with a pathological fracture. The cyst was curetted and the arm put up in abduction in a plaster spica. An excellent result was obtained.

CASE XX.—F. J., male, aged thirty-five, was admitted to Memorial Hospital April 29, 1931, two days after he had struck the left side of his chest in a fall. X-ray films revealed a recent pathological fracture through a cystic area of apparently long duration in the eleventh rib. Two X-ray treatments were given over the involved area with marked relief of pain, though the patient continues to have some discomfort at the site of the lesion.

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CASE XXI.—B. W., female, aged forty-one, was admitted to the Hospital for Ruptured and Crippled April 10, 1932. Twenty-three years ago the patient fell on a dance floor and fractured the right femur. This apparently healed without complication until six months ago (eighteen years later), when he began to have pain at the site of the original injury. An X-ray film revealed a bone cyst in the middle of the shaft of the right femur. Eight X-ray treatments were given, but pathological fracture through the cyst occurred. The cystic area was then curetted and a bone graft from the right tibia inserted. A plaster spica was applied for eight weeks and then the patient was permitted to walk with crutches. Six months after operation full weight-bearing was allowed. Progress has been satisfactory. While there is 4 centimetres of shortening and a con-



FIG. 8.



FIG. 9.

FIG. 8.—(Case XXIII.) Healed bone cyst. Appearance nine years after first, two years after second, pathological fracture. Perfect function. Shortening of humerus of five centimetres. Gives no symptoms.

FIG. 9.—(Case XXIV.) Showing healing, with some coxa vara deformity, nine months after treatment of a bone cyst with pathological fracture of the neck of the femur. Treatment—immobilization, after reduction, in Whitman plaster spica.

sequent slight limp, it is too early, eleven months after operation, to judge of the end-result.

CASE XXII.—R. C., female, aged twenty-two, was admitted to Memorial Hospital August 30, 1930, with a history of pain in the thigh of two years' duration, becoming more severe and not responding to eight X-ray treatments. X-ray films revealed a cystic area in the upper end of the left femur and further X-ray treatments were given with later evidence of bone repair and relief of symptoms.

CASE XXIII.—S. B., male, aged thirteen, was admitted to Memorial Hospital January 25, 1928. In 1922 the patient injured his right arm while at play and an X-ray film taken at that time revealed no fracture, but when reviewed later was found to show a bone cyst in the upper end of the right humerus. He remained symptom-free for six years, but began to complain of pain and disability, one month before admission. He was

kept under observation for ten months; then, while playing handball, sustained a pathological fracture through the cystic area. This healed rapidly in four weeks, but with two inches of shortening. (Fig. 8.) The shortening has remained unchanged, but the patient exhibits full range of motion at the shoulder and excellent function of the arm.

CASE XXIV.—H. G., male, aged thirteen, was admitted to the Hospital for Ruptured and Crippled January 8, 1926, with a history of pain in the thigh of insidious onset and one and a half years' duration. X-ray studies showed a cystic area in the upper end of the left femur with pathological fracture. (Fig. 9.) A plaster cast was applied for four weeks and an excellent anatomical and functional result was obtained.

CASE XXV.—P. F., female, aged nine, was admitted to the Hospital for Ruptured and Crippled March 11, 1930, immediately following an injury to her right arm. X-ray revealed a cystic area in the mid-shaft of the right humerus. This was curetted and a bone graft inserted. Recent examination reveals an excellent anatomical and functional result.

CASE XXVI.—L. P., male, aged four, was admitted to the Hospital for Ruptured and Crippled January 27, 1930, complaining of pain in the hip and persistent limp following an injury eight months previously. X-ray examination showed a bone cyst in the upper end of the right femur. This was curetted and bone grafted, and recent examination shows an excellent result.

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POST-TRAUMATIC ACUTE BONE ATROPHY (SUDECK'S ATROPHY)

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OF MONTREAL, CANADA

FROM THE MONTREAL GENERAL HOSPITAL

As is well known, it is the rule to find that the bones of extremities which have been put at rest for any considerable length of time, for any reason, such as prolonged bed-confining illnesses, fractures, or paralyses, become less resistant to the X-ray and consequently throw a less dense shadow, and that they are smaller than normal. Such a condition of bone atrophy is of comparatively little importance since, upon resumption of function, the bones gradually, comparatively quickly, and surely regain their normal density, and increase in diameter. In the meantime, moreover, there are no symptoms experienced by the individual referable to the absorption of calcium from the bones.

Cases are occasionally observed, however, which demonstrate atrophy, or osteoporosis, of an entirely different type. In the first place, the bone changes occur rapidly; with few exceptions they are exhibited within a few days or weeks following injury. The original traumatism is, as a rule, not severe, but, it would appear, is usually repeated either as the result of a second or third trivial accident, or as the result of irritation in the course of treatment. Characteristically, the original injury is in the neighborhood of a joint, more especially those parts in which many joint surfaces are seen in close association, such as the wrist and tarsus. In this type of atrophy, röntgenograms show a very typical patchy (*flächlich*) or "moth-eaten" appearance of the bones in the immediate vicinity of the traumatized area and, also, in the bones distal to the region which has apparently been hurt.

The author is of the opinion that the importance of acute bone atrophy, as a cause of temporary disability, is not sufficiently well recognized by the majority of surgeons, in that innocent persons are accused of malingering, and also that a small number of surgeons prove their unfamiliarity with the condition by recommending too heroic measures, *e.g.*, amputation, for its treatment. The opinions expressed under oath by surgeons of experience and authority, in connection with the results of injury leading to litigation, in which the author has been interested, prove these facts to be true. In this contribution cases of acute bone atrophy following trauma will alone be considered.

A recent article by Fontaine and Herrmann,¹ published from Leriche's Clinic in Strasbourg, describes the condition under the title of "Post-Traumatic Painful Osteoporosis." The application of this name to the condition is significant, and, except for the fact that it is cumbersome, might well be adopted. Fontaine and Herrmann's article is noteworthy in that

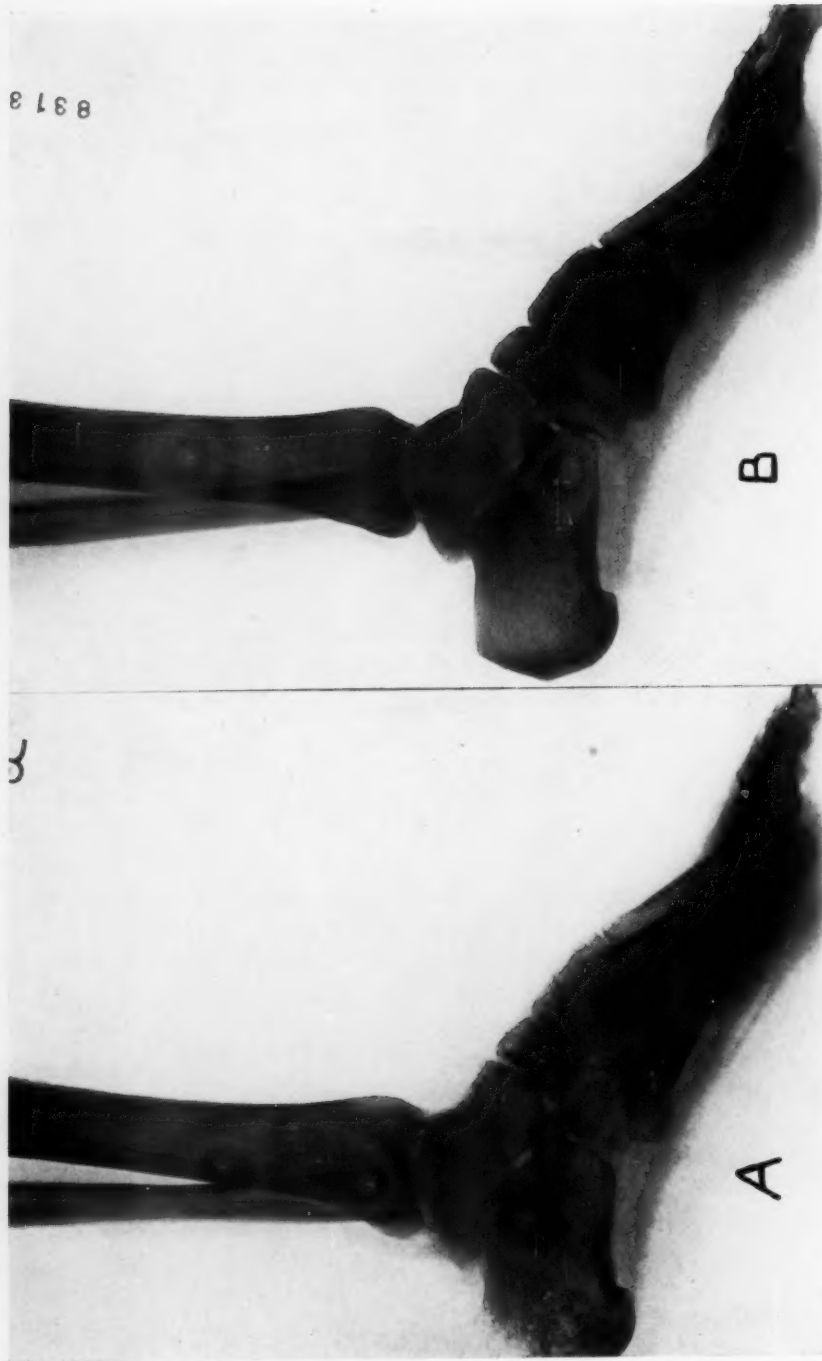


FIG. 1.—(Case IV.) (P.L.) Röntgenograms of both feet three months after fracture of sesamoid. Note typical patchy osteoporosis of right foot (A).

POST-TRAUMATIC ACUTE BONE ATROPHY

ninety-one references are included, of which but nine (only one, Noble and Hauser,² deals in fact with acute bone atrophy), refer to articles published by English-speaking authors. Of the remainder, forty-one have their origin in France, and thirty-eight made their appearance in German literature. Eight articles, published between 1923 and 1930, are from the pen of Leriche himself.

Acute bone atrophy of a specific type was first described by Sudeck³ in 1900; during the following two years this author made further contributions.^{4, 5} Although, in the intervening years since that time, a certain amount of data have accumulated with reference to the symptomatology and pathological findings, and, to a limited extent, with reference to treatment, no adequate explanation of the cause of the condition has been generally accepted.

Willich,⁶ following Beck, classifies the etiological factors of bone atrophy as follows: (1) Atrophy due to deficient nutrition. (2) Disuse atrophy. (3) Senile atrophy. (4) Acute reflex (*reflektorische*) atrophy (Sudeck's). (5) Neuropathic atrophy.

Willich, in a recent article, draws attention to the great clinical interest in the question of bone atrophy. Despite the number of contributions by German writers on the subject since Sudeck's first article, the matter, he says, is not yet explained.

At the 1921 (16th) and 1928 (23rd) Congresses of the German Orthopedic Association, the main topic under consideration was the condition discussed in this contribution. In 1928, the subject was opened by Beck,⁷ who reviewed our knowledge of the condition up to the present. He suggested that disturbances in the circulation, particularly in the sense of an increased capillary and venous pressure, which results in a local accumulation of carbon dioxide, stimulates osteoclastic absorption of the bone. He indicated that Sudeck's atrophy seems to be due to a collateral hyperæmia. He stressed the importance of œdema, cyanosis, and atrophy of the skin, changes which are always present in the presence of acute bone atrophy, as indicating a disturbance in circulation. It will be noted that these views are in agreement with those recently brought forward by Grieg,⁸ of Edinburgh, in that he believes calcium absorption from bone to be due to a nimity of blood supply.

Beck's paper was discussed by Grashey, who stressed the importance of identical technic in making röntgenograms of similar parts, Rabl, who supported the theory of inactivity, and by Spitzzy, Koenigswieser, Schede, Hilgenreiner and Goecke. Koenigswieser names the condition of acute bone atrophy traumatic osteomalacia.

Diagnosis and Clinical Course.—The clinical appearance of a case of acute bone atrophy is fairly typical. Within a few days after the reception of the injury, usually trivial or relatively so, the foot or hand, which has been somewhat swollen and painful immediately following the injury, becomes progressively more swollen and more painful. Although it is possible to palpate the pulse pressure in the blood-vessels in the neighborhood of the ankle or wrist, it appears evident from an examination of the limb that the

capillaries are engorged and that an increase in interstitial tension has taken place. The appearance of the affected part indicates an atrophy of tissues other than the bones. The skin becomes smooth, tends to lose its characteristic markings, and may become "glossy."

The joints rapidly become stiff, and movements, either active or passive, are extremely painful. Although it is possible to induce diminution in swelling by means of posture, this effect is brought about only with difficulty, in that prolonged elevation is required. Absolute rest to the member usually, or always, is followed by relief from pain; even a minimal attempt at movement, either active or passive, or unprotected weight-bearing, is extremely ill-borne. That atrophy of the ligamentous tissues accompanies the bony lesion is proven by the likelihood of subluxation, either grossly as in Case VII or by the development of extensive and painful flat foot. That the cartilaginous ends of the bones may atrophy is shown by the exhibition of bony ankylosis in certain cases, as in some reported by Fontaine and Herrman.

Röntgen examination made within a few weeks from the date of injury shows a very characteristic "patchy" atrophy of the bones in the immediate neighborhood of the injury and also in the bones distal to the site of injury. To a less marked extent, similar changes are seen in the bones immediately proximal to the traumatized area. In the case of injuries about the ankle and foot, it is usual to find the lower fifth of the tibia and the distal extremity of the fibula involved in the atrophic process; likewise, the lower end of the radius is involved in the case of carpal and hand injuries. In the case of the shoulder, both scapula and upper part of the humerus are seen to be the site of osteoporosis.

Sudeck, in his first contributions, divided the disease into two stages: (a) the acute, and (b) the chronic form. It is the acute stage which, I believe, is of most importance, since in the first place it is more readily diagnosed and in the second place is, I believe, more susceptible to conservative treatment. In the article by Fontaine and Herrmann, previously referred to, they have reported a number of cases, more especially at the chronic stage, and, it would appear, have been successful in indicating at least one form of treatment for such cases. They divide the disease into three stages: (a) the onset, (b) the height of the disease, and (c) the reorganization. It is in what they refer to as the "onset of the disease" that the typical patchy appearance of the bones is noted on the röntgenogram. At the "height of the disease" the irregular areas of rarefaction disappear and the bones become uniformly permeable to the Röntgen-ray. During the "period of reconstruction" or reorganization, there is a slow reappearance of calcium in the bones. Fontaine and Herrmann state that in most cases complete recalcification never takes place. In the author's experience this is probably correct, although it is evident that complete return of function may be expected without an absolutely normal X-ray appearance.

Fontaine and Herrmann express the opinion that the oscillometric index

POST-TRAUMATIC ACUTE BONE ATROPHY

is of great value in determining the existence of the vasomotor disturbance. They report that in seven cases of osteoporosis of the bones of the wrist, the oscillations were six times stronger in the affected forearm than at the same level in the normal forearm, and that in six cases of the disease about the ankle they found a marked increase in the oscillations of the lower third of the affected leg, in five cases. The author has not employed this method of examination.

Clinical diagnosis is dependent upon the presence of the signs indicated in the first paragraph of this section, particularly when the loss of function and pain are out of all proportion to importance of the original trauma. Radiological differentiation is most important in the acute state since tumor

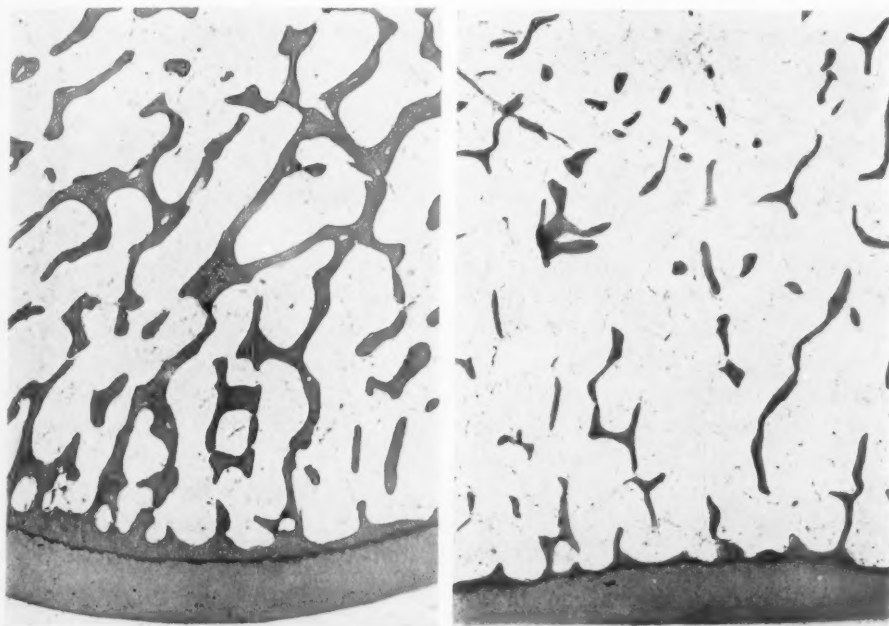


FIG. 2.—Photomicrograph of carpal bones from both normal and diseased wrists. In this case there was röntgenological evidence of fully developed acute bone atrophy of right hand. (Fontaine and Herrmann.) (Courtesy ANNALS OF SURGERY.)

may be considered. It is during the second stage, or height of the disease, that the diagnosis of tuberculous osteo-arthritis is likely to be made.

Pathology.—Comparatively few observers have had the opportunity of examining the porotic bones, either in the gross or microscopically. Vialleton⁹ (1922) reported the histological examination of two cases and found a disappearance of all the transverse striæ and a diminution of the longitudinal striæ. The Haversian canals become very large and the cortex becomes very thin. The bone absorption is apparently not the result of osteoclastic activity since these specific phagocytes were not seen in any of the preparations. It would appear that there is a uniform loss of bony substance and not merely a depletion of the mineral salts of the bone.

Fontaine and Herrmann have had the opportunity of examining bones

from two cases. I am indebted to Dr. Lewis S. Pilcher, Editor of the *ANNALS OF SURGERY*, for permission to republish photomicrographs showing the difference in the histological structure of a carpal bone from the right hand in which there was röntgenological evidence of fully developed osteoporosis and the histological structure of the carpal bone from the opposite hand. It will be noted that there is a diminution in the number and thickness of the bony lamellæ in the osteoporotic hand.

Muscle atrophy, as well as atrophy of the subcutaneous tissues, is present. The skin is thinned and may be glossy. Atrophy of the ligamentous tissue would appear to be invariably present and, as in Case VII, such atrophy was so marked that subluxation of the subastragaloid joint occurred. Synostosis of the carpal bones, as observed at Leriche's Clinic, would appear to prove atrophy of cartilage.

Site and Frequency.—Acute bone atrophy is rarely, if ever, noted in the diaphyses of the long bones. It is most frequently seen in the short bones of the carpus and tarsus. It is not infrequently present in the epiphyses of the metatarsals, metacarpals and phalanges. As a rule, in cases in which carpus or tarsus is involved, the epiphyseal ends of the bones of the forearm or leg exhibit a characteristic halisteresis. If the condition described by Kummell in 1895 of atrophic changes in the vertebral bodies be, in fact, as seems probable, an example of the same condition, the phenomenon of acute bone atrophy is found most commonly in the foot and ankle, somewhat less frequently in the hand and carpus, and also in the spine. Hitherto, except for a few questionable cases, there has been no general recognition of the condition elsewhere in the body, although Noble and Hauser² report cases in the neighborhood of the knee-joint. A recent case seen by the author indicates that a similar phenomenon is exhibited following injuries in the neighborhood of the shoulder-joint. Cases of painful osteoporosis about the shoulder have also been reported from Leriche's Clinic, Strasbourg. Schüller¹⁰ (1929) reported typical examples of post-traumatic rarefaction of the skull. Fontaine and Herrmann report having seen one case exhibiting this condition.

That the condition is an unusual one is evident from the fact that during twelve years, namely, from 1912 to 1924, only forty-eight cases, diagnosed as acute bone atrophy, were treated at The Mayo Clinic.² Of these cases, forty-one were in the lower limbs, six in the upper limbs and one in the spine.

Noble and Hauser state that of these cases, twenty-seven followed minor trauma, twelve were either spontaneous or due to an unrecognized trauma, and two were due to fractures of both bones of the leg. Of the six cases which occurred in the upper limbs, five were a complication of Colles fracture and one followed a manipulation of the shoulder complicated by a traumatic neuritis of the ulnar nerve. Of the cases seen at The Mayo Clinic, the average time elapsing between the receipt of the trauma and examination was three and one-half months. The one case of Kummell's disease occurred in a man aged forty-two, eight weeks after a direct trauma to the back.

POST-TRAUMATIC ACUTE BONE ATROPHY

TABLE I
Analysis of Cases—Fontaine and Herrmann

Case	Sex	Age	Time after Injury First Seen	Nature of Injury	Part Affected	Treatment	Result
II	M.	57	4 mos.	Contusion, hand	Hand	Ganglionectomy	Died.
III	M.	57	3 mos.	Fracture, shoulder	Humerus, elbow and hand	Ganglionectomy (?)	Death six months later. Recovery incomplete.
IV	M.	17	6 mos.	No history, trauma	Hand (Röntgen diagnosis—tuberculous osteo-arthritis)	Peri-arterial sympathectomy	Cure.
V	M.	47	3 mos.	Contusion, hand	Hand (Röntgen diagnosis—tuberculous osteo-arthritis)	Peri-arterial sympathectomy	Ankylosis, wrist-joint. Functional cure.
VI	F.	54	5 wks.	Sprain, wrist	Hand (Röntgen diagnosis—tuberculous osteo-arthritis)	Peri-arterial sympathectomy	Functional cure. Radiological recalcification incomplete.
VII	F.	59	10 wks.	Colles	Hand (Röntgen diagnosis—tuberculous osteo-arthritis)	Peri-arterial sympathectomy	Six months' cure, both functional and radiological.
VIII	F.	65	2 mos.	Colles	Hand	Peri-arterial sympathectomy	Four months' good recovery, both functional and radiological.
IX	F.	41	2 mos.	Colles	Hand	Peri-arterial sympathectomy	Five months' functional recovery. Radiological recalcification incomplete.
X	F.	65	5 mos.	Contusion, hand	Hand, elbow and shoulder	Ganglionectomy	Slow recovery. Five and one-half years functionally complete, radiologically incomplete.
XI	M.	45	12 mos.	Contusion, foot	Foot	Ganglionectomy	Four months' cure, functionally and radiologically.
XII	M.	27	3 wks.	Contusion, foot	Foot	Peri-arterial sympathectomy	Six months' cure, functionally and radiologically.
XIII	M.	25	2 mos.	Contusion, foot	Foot (radiological diagnosis—tuberculous osteo-arthritis)	Peri-arterial sympathectomy	Four months' cure.
XIV	F.	39	4 mos.	Sprain, ankle	Foot	Peri-arterial sympathectomy	Five months' clinical cure, slight recalcification.
XV	F.	27	several mos.	Sprain, ankle	Foot	Peri-arterial sympathectomy	Five months' clinical cure.
XVI	M.	38	3 mos.	Operation, infection great toe	Foot	Peri-arterial sympathectomy	Two years' cure, functionally and radiologically.
XVII	F.	31	2 mos.	Potts fracture	Foot (radiological diagnosis—tuberculous osteo-arthritis)	Peri-arterial sympathectomy	Eight months' moderate cure, functionally and radiologically.
XVIII	M.	56	5 mos.	Contusion, shoulder	Shoulder	Peri-arterial sympathectomy	Two months' clinical cure.
XIX	M.	57	3 wks.	Contusion, shoulder	Shoulder (slight decalcification only)	Peri-arterial sympathectomy	Temporary relief; return of symptoms. (Question diagnosis—F. B. G.)
XX	M.	57	5 wks.	Contusion, shoulder	Shoulder	Peri-arterial sympathectomy	Four months' clinical cure.
XXI	M.	39	4 mos.	Contusion, shoulder	Shoulder (moderate rarefaction humerus)	Peri-arterial sympathectomy	No improvement.
XXII	M.	35	1 mo.	Contusion, shoulder (complicated)	Shoulder	Peri-arterial sympathectomy	Relief of pain; no improvement in movement.

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XX	M.	57	5 wks.	Contusion, shoulder	Shoulder	Peri-arterial sympathectomy	Four months' clinical cure.
XXI	M.	30	4 mos.	Contusion, shoulder	Shoulder (moderate rarefaction humerus)	Peri-arterial sympathectomy	No improvement.
XXII	M.	35	1 mo.	Contusion, shoulder (complicated)	Shoulder	Peri-arterial sympathectomy	Relief of pain; no improvement in movement.

Fontaine and Herrmann report in detail a series of twenty-one cases, of which nine involved bones of the wrist, seven bones of the ankle, and five occurred in the vicinity of the shoulder-joint. An analysis of their cases is shown in Table I.

Boehler¹¹ pictures the condition and, although he makes no reference to its etiology or specific signs or symptoms, in characteristic fashion he indicates treatment. This is the same as that which has been employed by the author, namely, the application of a non-padded plaster case and weight bearing. The case is applied after all œdema has been gotten rid of by posture.

During the past six years, I have had under observation fourteen well-marked cases of bone atrophy. Of these, but one developed in a case under my own care. (Case II.) Of the fourteen cases, nine were complications of injuries, all more or less trivial, of the foot or in the neighborhood of the ankle-joint; four involved the hand; two followed Colles fractures; and two a simple contusion of the hand, in which no fracture was demonstrable. One case of shoulder-joint involvement has been recently seen. No case involving the knee-joint has been recognized as being a case of acute bone atrophy.

The accompanying table shows that the age limits among the author's cases were twenty-one and fifty-eight years. The average was 38.4 years. Fontaine and Herrmann's cases were between seventeen and sixty-five years, the average age being forty-four years.

Although only fourteen cases of well-established and typical bone atrophy have been seen by the author during the six-year period, and although other authors have hitherto reported but few cases, it is evident, I believe, that less typical lesions occur not infrequently, but since most methods of treating fractures, sprains and contusions are at least relatively useful in the care of cases of acute bone atrophy, the disease does not progress and the part returns to useful function even though at the expense of time.

Theories Regarding Causation.—Sudeck,³ in his original paper, believed that the condition was a low-grade inflammation, but two years later, in 1902,⁵ he agreed with Kienbock,¹² who brought forward the theory of the condition being a manifestation of a trophoneurosis.

Vialleton⁹ (1922) examined tissues removed from atrophic bone. He failed to find any evidence of cellular infiltration of an inflammatory nature. Fontaine and Herrmann, who also had an opportunity of examining both porotic and normal bone from different limbs, failed to prove any evidence of an inflammatory lesion. It may be said, therefore, that the condition of acute bone atrophy has been proven to be not, as Sudeck first thought it to be, an inflammatory process.

Two hypotheses, only, would appear to be worthy of any consideration, concerning the cause of the condition. One theory assumes that osteoporosis is due to disuse or absence of stimuli due to function. The second hypothesis explains the disease as being the direct result of the trauma and that the

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TABLE II
Analysis of Author's Cases

Case	Name	Part	Year	Age	Sex	Time after Injury Diagnosis Made	Time after Injury Last Seen	Treatment	Result at Last Examination	Nature of Injury
I	C. O.	Foot	1926	34	M.	2 mos.	11 mos.	Walking plaster	Recovery. Non-cooperative.	External rotation fracture ankle, Grade I.
II	V. T.	Foot	1927	21	M.	2 mos.	6 mos.	Hot baths	Recovery. Cooperative.	Substragloid dislocation, Fracture astragalus.
III	M. A.	Foot	1927	40	M.	5 mos.	17 mos.	Walking plaster	Recovery.	Ex. rot. fracture fibula, Grade I.
IV	P. L.	Foot	1928	46	M.	3 mos.	3 yrs.	Walking plaster	Radiological recovery. Non-co-operative (Simistrose).	Fracture sesamoid.
V	C. U.	Foot	1928	35	M.	3 mos.	—	Not treated	Lost sight of.	Fracture sesamoid.
VI	T. O.	Foot	1930	41	M.	3 mos.	6 mos.	Walking plaster	Returned to Europe. Recovery incomplete but favorable.	Fracture first metatarsal.
VII	D. E.	Foot	1931	42	M.	5 mos.	12 mos.	Walking plaster	Recovery. Very cooperative.	Chip fracture os calcis. Chip fracture first metatarsal.
VIII	L. A.	Hand	1931	35	F.	6 wks.	—	Plaster-of-Paris	Not seen again.	Colles fracture.
IX	B. I.	Hand	1931	49	F.	5 wks.	20 mos.	Heat manipulation	Recovery radiological; recovery clinical.	Contusion of hand. No fracture.
X	M. G.	Hand	1932	51	F.	5 wks.	6 mos.	Diathermy; active exercise	Recovery radiological; recovery clinical.	Colles fracture.
XI	W. A.	Foot	1932	48	M.	8 wks.	7 mos.	Walking plaster	Recovery radiological; recovery clinical.	Ex. rot. fracture ankle-joint, Grade III.
XII	T. W.	Foot	1932	45	M.	3 mos.	5 mos.	Walking plaster	Much improved.	Compound fracture great toe.
XIII	T. Q.	Shoulder	1932	37	M.	2 mos.	6 mos.	Diathermy	Improving.	Dislocation shoulder; fracture tuberosity.
XIV	W. E.	Hand	1933	58	M.	14 mos.	14 mos.	Not treated	Recently seen for first time. Radiological, patchy atrophy. Clinical; swelling; pain; stiffness.	Contusion, hand.

bone atrophy is consequent upon reflex action influencing the blood supply. That inactivity does result in a certain type of atrophy of bones, as of other structures, is, of course, evident. At the same time, the type of atrophy under consideration in this contribution shows both clinical and radiological features which are only rarely exhibited. It would appear, therefore, that in addition to disuse *per se* some other factor must be operative.

The experiments of Grey and Carr,¹³ seem to prove that injury to the sensory nerves is not followed by local atrophy, whereas injury to the motor nerves is followed by a certain amount of atrophy. Such atrophy is apparently indirect since it is in proportion to the paralysis produced. Local venous congestion causes no recognizable effects in the bone structure; local anæmia, unless this be extreme, is likewise followed by no bone atrophy. Atrophy, due to inactivity, may become noticeable within four or five days after immobilization in rabbits.

Many experiments, more especially those of Brandes¹⁴ (1913), Grey and Carr¹³ (1915), and Allison and Brooks¹⁵ (1921), have been carried out on animals in an attempt to reproduce the condition of acute osteoporosis found in man. These experiments have shown that atrophy, as the result of disuse or inactivity, may become noticeable within four or five days. In none of these experiments, however, would it appear that the specific condition, which is the basis of this contribution, has been brought about. The explanation for atrophy due to inactivity, given by Grey and Carr, is perhaps a compromise upon the two main hypotheses. They express the opinion that the atrophy, such as they obtained in four or five days after immobilization in rabbits, may be due to decrease or absence of the functional stimuli necessary to the normal nutrition of bone.

Possibly the most important direct evidence obtained by Allison and Brooks, and Grey and Carr, is that neither local venous congestion nor local anæmia is followed by bone atrophy.

Fontaine and Herrmann suggest that "the fact that osteoporosis is more frequent after trauma to the polyarticular regions, such as the ankle or the wrist, is suggestive evidence that stimulation of the numerous articular and peri-articular nerves brings about the vasomotor changes that are ultimately responsible for the production of the osteoporosis." Fontaine and Herrmann's contribution, as well as other articles from Professor Leriche's clinic, have stressed the local hypervascularization as shown clinically by the increased local temperature and the increase of the oscillometric index, in the early stages of osteoporosis. Leriche and Policard, as well as Grieg,⁸ have shown that hyperæmia is a necessary factor for the absorption of bone. Fontaine and Herrmann are of the opinion that true osteoporosis (acute bone atrophy) is the direct result of the hyperæmia produced by vasomotor changes that result from reflexes that originate in the traumatized area.

Although definite experimental proof has not been forthcoming, it would appear that acute bone atrophy occurs as the result of nerve stimuli being transmitted through the sensory nerves from the neighborhood of the

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traumatized tissues through the spinal ganglia and that in consequence stasis and accumulation of blood takes place in the periphery of the affected limb. In other words, acute bone atrophy is a phenomenon brought about by vascular changes through reflex channels, or as formulated by Noble and Hauser, this theory explains acute bone atrophy as being reflex trophoneurotic in origin, a disturbance in the metabolism of the bones being produced so that the bone substance is broken down more rapidly than it can be reconstructed.

If the condition of acute bone atrophy, as seen in man, be in fact due to reflex arc stimulation, in consequence of pain initiated at the site of injury, failure to reproduce the same condition in laboratory animals may well be due to the presence of a more primitive nervous system in such animals.

Treatment.—That the process of bone atrophy is reversible is, I believe, proven by the results of treatment. At the same time, recovery from the condition may be extremely slow and the patience of surgeon, patient and responsible insurance company, or Workmen's Commission, is likely to be strained. The period required for clinical, if not radiological, cure is likely to be from six months to a considerably longer time.

The author is of the opinion that freedom (with one exception, V.T.,¹⁶ Case II) from the development of the condition among our own cases, during the past twelve years, has been due in large measure, particularly in the case of the lower extremities, to the fact that unpadded plaster-of-Paris bandage envelopes, with consequent protected weight-bearing, has been employed¹⁷ as a routine in fractures of the foot, ankle-joint and leg. In the case of the wrist fractures the employment of snugly fitting plaster bandages, with early function, protects, we believe, from the syndrome responsible for acute bone atrophy.

Treatment in the case of the lower extremity necessitates confinement of the patient to bed for a period of three or more days, with the limb elevated, in order that all interstitial oedema may be gotten rid of. A silk stocking* is then placed on the limb and a plaster-of-Paris bandage applied from the toes to the knee, in the case of foot and ankle-joint lesions. This bandage is made to cover the fourth and fifth toes, and is accurately molded to the contours of the limb, more especially to the expanded upper portion of the tibia and to the lower border of the patella. Special attention must be paid to reinforcing the plaster in the neighborhood of the heel and ankle-joint. When the plaster is dry, the saddler's felt heel, one inch in thickness, previously described by the author,¹⁷ is fixed to the heel of the plaster by means of adhesive strapping.

When such an apparatus has been applied, it is possible for the patient to walk on the limb without the use of crutches or a stick, and with a minimum amount of discomfort. As a rule, in cases of acute bone atrophy, considerable effort is required to induce the patient to coöperate, since they are characteristically extremely fearful. At the same time I believe that the

* An adequate supply of stockings is always available, without cost, from the waste baskets of the Nurses' Home.

length of time required for recovery from the condition will be in inverse ratio to the amount of walking carried out in the interval.

In the case of the upper extremity, either fixation in an unpadded plaster, or better, I believe, the employment of diathermy with careful instructions in the use of active exercises which must not cause pain, may be counted upon to bring about cure of the condition.

Noble and Hauser believe that the tendency is for acute bone atrophy to run its course, and that the results of efficient treatment are practically always satisfactory. As they point out, the convalescent period may take many months—even years. They recommend heat to the point of tolerance and advise against the use of braces and casts. The author is in wholehearted agreement with their objection to the use of forcible manipulation.

Fontaine and Herrmann state that since 1924 all cases of osteoporosis admitted to the clinic of Professor Leriche have been treated by sympathectomy, either peri-arterial or ganglionectomy. They express the opinion that operations upon the sympathetic nervous system offer a rational and effective treatment for this disease entity, and that early treatment in this fashion results in a rapid improvement and the prevention of undesirable sequelæ. These authors point out that it is difficult to explain the mechanism by which this improvement is brought about, since it would appear that the operation of sympathectomy should be contra-indicated in a disease which is caused by hypervascularity of the extremity. They state, however, that the clinical fact remains that improvement can be obtained equally well in cases of osteoporosis with vasodilation, as in those with vasoconstriction as the dominant clinical sign. Since there would appear to be no doubt as to the efficacy of interference with the sympathetic nerve supply to the affected part, and since such usefulness is not explained by the effect, of such operations, upon the blood-vessels, may it not be that such favorable results are due to destruction of the sympathetic innervation of the tissues *per se*?

The author is of the opinion that such a radical procedure as sympathectomy can only be justified in but a small proportion of cases, since as a rule, at least, clinical cure can be obtained by conservative measures, especially if certain contra-indicated procedures are avoided, more especially, painful manipulation with or without the employment of anæsthesia. In the author's group of fourteen cases, in two complete functional recovery occurred; in four others the results were good. In four cases the final result is not known; of these a favorable result was looked for in two, while in the remaining two a poor result seems inevitable. Three cases, still under treatment, are progressing favorably and comparatively quickly. One case has been but recently seen for the first time.

The following case histories are reported in some detail since they each demonstrate certain characteristic features regarding the history, clinical phenomena, radiological appearance and progress of the condition of acute bone atrophy.

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CASE III.—M. A., aged forty, longshoreman. This man was injured November 2, 1926, when he was knocked over by a board. He is said to have fractured the left

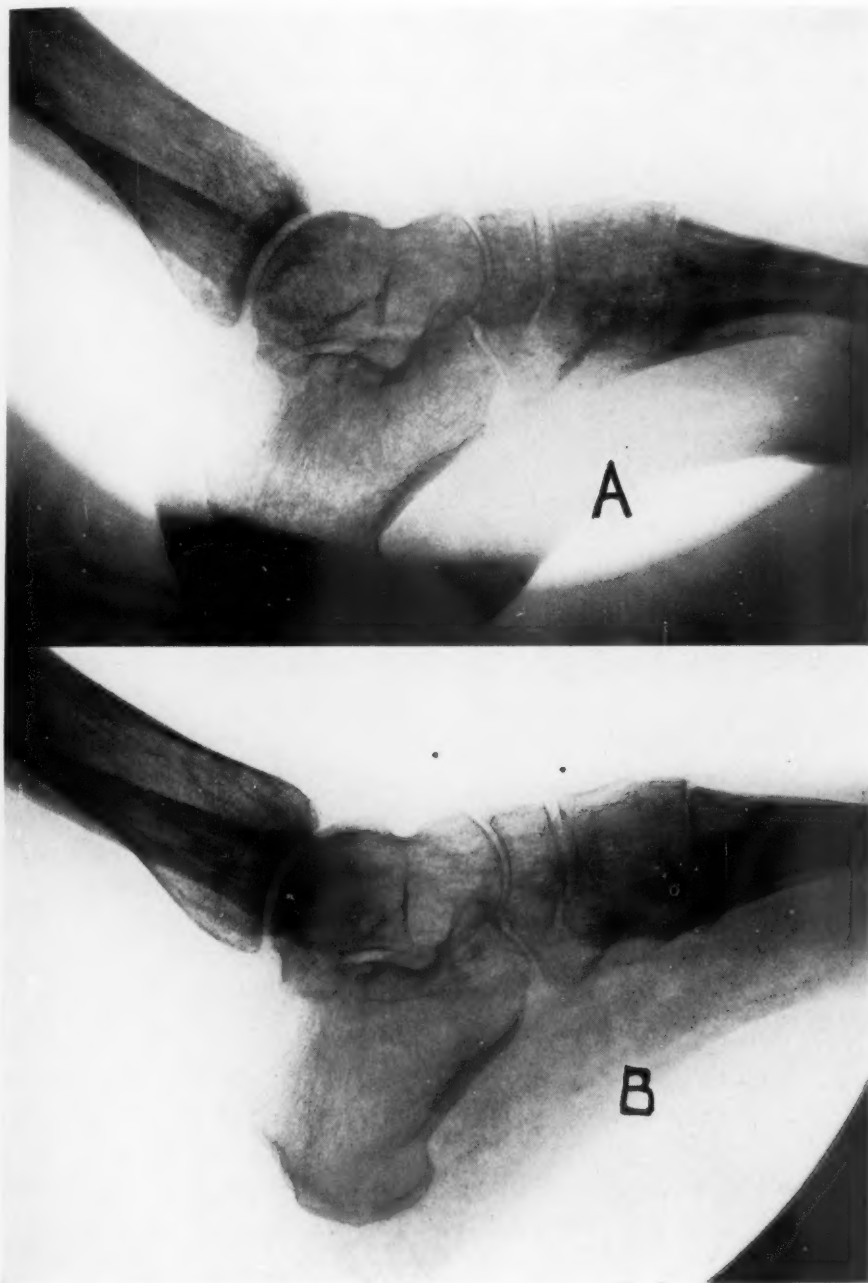


FIG. 3.—(Case III.) (M.A.) Röntgenograms (A) April 8, 1927, five months following fracture fibula, shows moderate acute bone atrophy. (B) January 4, 1928, shows marked evidence of recalcification.

fibula about the junction of the middle and lower thirds, although subsequent X-ray examination did not establish this fact. The affected leg was placed in a molded, incom-

plete plaster splint a few days after injury. Since the condition of his leg following removal of plaster was most unsatisfactory, I was asked to see him during April, 1927. At this time the whole of the leg and foot were moderately to markedly swollen and extremely tender. The patient complained of the slightest pressure at any point, and attempts to move the joints of the foot were accompanied by so much pain that it was impossible to properly examine the limb. X-ray examination made April 8 (Fig. 3)

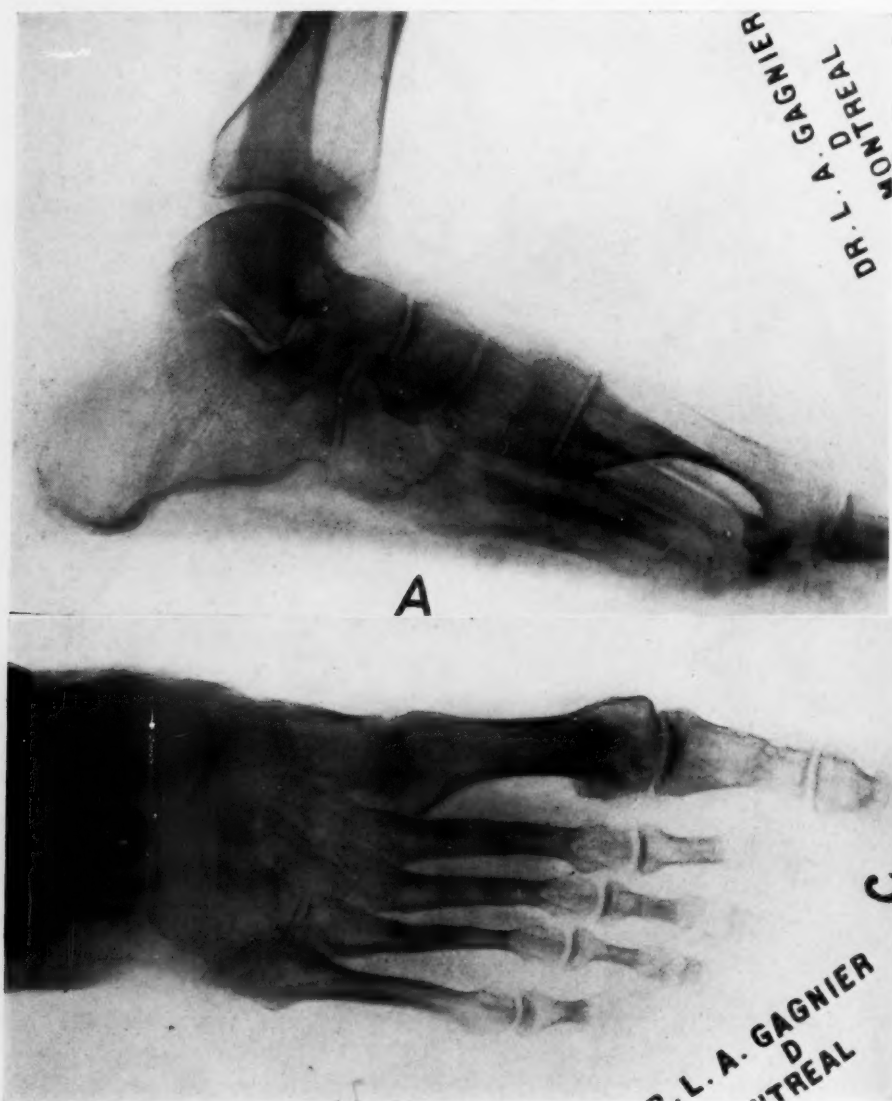


FIG. 4.—(Case VII.) (D.E.) Röntgenograms (A) and (C). Right foot showing atrophy eight months after injury; clinical improvement already noted.

showed marked patchy atrophy of all the bones of the foot and lower third of both tibia and fibula.

During the month of May the limb was seen by one of the most prominent surgeons in Montreal, who advised amputation of the limb on account of swelling and pain and, more especially, the atrophic condition of the bones as shown by X-ray.

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In January, 1928, although no special treatment other than hot bathing had been employed with a view to correcting the bone atrophy, the condition of the patient's limb had improved much. Swelling had largely subsided, tenderness was much less marked and X-ray examination showed the bones to be returning to a more or less normal appearance. From this time return of function progressed somewhat rapidly so that by the time navigation opened in the spring of 1928 the man was ready to return to work. At the time of his return to work toward the end of April, function of his limb was practically normal.

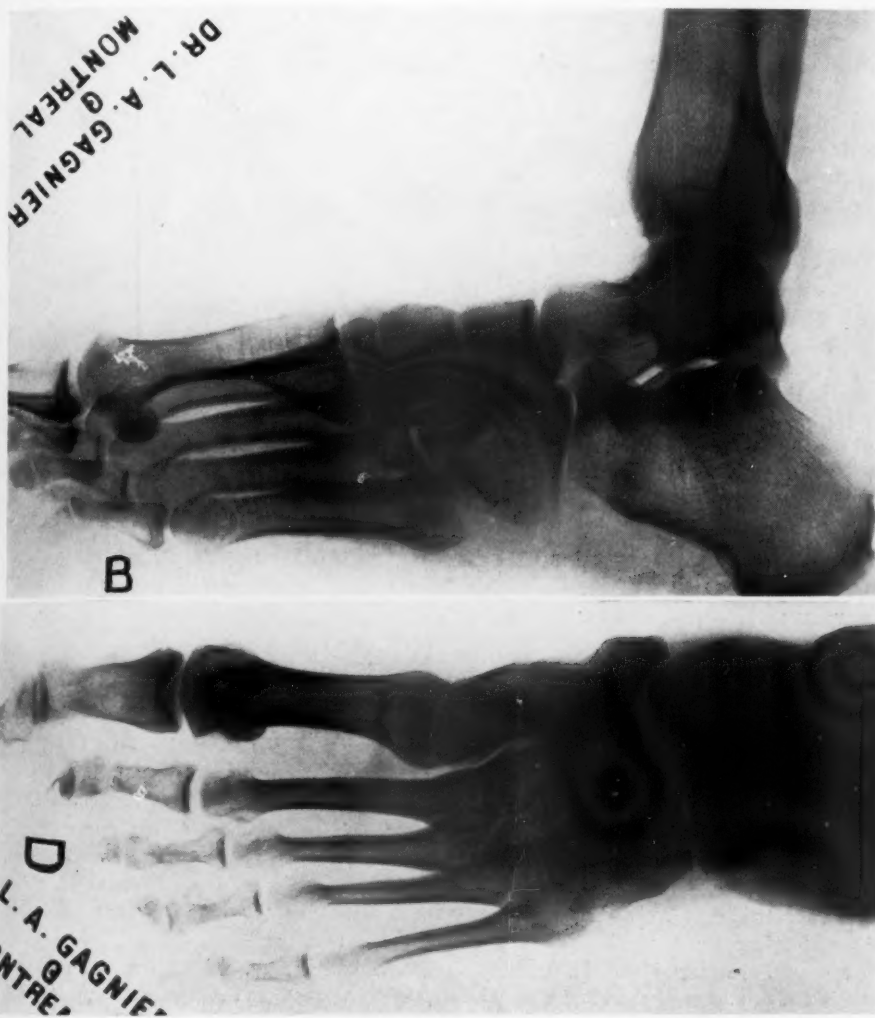


FIG. 5.—(Case VII.) (D.E.) Röntgenograms (B and D). Normal foot for comparison with Fig. 4.

CASE VII.—D. E., forty-two years. Injury April 18, 1931. On April 25, Doctor Gagnier examined this man and reported a small fracture of the os calcis, also a fracture of the first metatarsal with very slight displacement.

On September 26, 1931, I first saw him at my clinic at the Montreal General Hospital, at which time he complained of swelling of the right leg and foot and of extreme pain. When the man stood erect upon the foot, the most extreme grade of pronation occurred, accompanied by subluxation of the subastragaloid joints, and, although he was

able to walk a few steps, he did so only with the greatest difficulty. At this time X-ray examination was made at the Montreal General Hospital and showed no evidence of fracture, but did show a definite condition of acute bone atrophy (Sudeck's atrophy). A walking plaster was applied, after œdema of the limb had been induced to subside by means of posture.

He was next seen by me, through the kindness of Dr. I. Cote, December 17, 1931, with the note that the plaster-of-Paris had been removed November 6. He stated to me at that time, that at the time of removal of the plaster, the limb was free from swelling and looked normal, although he was not able to carry weight properly. At the time of my examination, December 17, he was walking with the help of a cane, with the foot held in a proper position and without any tendency toward pronation. Swelling was present to a marked degree and the whole foot and ankle-joint were tender and painful when passive movement was carried out. It was recommended, at this time, that a walking plaster-of-Paris cast be re-applied.

He was last seen by me April 19, 1932, at which time his general condition was excellent and he was able to walk comparatively long distances with the shoe on the affected foot tilted one-quarter of an inch. Both lower extremities, at this time, were alike in appearance. There was no swelling. Movements of both ankle-joints were normal, although there was slight spasm of the right foot. Although it had been previously easy for me to force the right foot into a marked pronation deformity with evident subluxation of the subastragaloid joints, I was on this date unable to carry out this manoeuvre. X-ray examination made April 12, 1932, showed that recalcification of the bones of the foot had largely taken place.

At this time, April, 1932, I expressed the opinion that the man would be able to return to work, although for a time such work would necessarily have to be of somewhat protected character. The chief permanent disability, in my opinion, in this case, was that due to the laxity of the subastragaloid ligaments.

The most interesting feature of this case, in the author's opinion, was the development of the subastragaloid laxity of ligaments, and the subsequent recovery of this condition under protected weight-bearing.

CASE IX.—Mrs. B. I., forty-nine years. This patient was injured August 13, 1931, as the result of a motor accident. She suffered from concussion, a wound in the neighborhood of the left knee and a severe contusion of the left hand. She was first seen by me October 1, 1931, at which time she made a specific complaint regarding the left hand and wrist, indicating a total loss of function of this member. The palm of the hand was flat and atrophic, the dorsum of the hand and fingers moderately to markedly swollen. The swelling extended to the lower end of the radius. Rotary movements of the forearm were normal. Movements of the wrist and fingers were extremely painful in all directions, except for the thumb, in which movements were moderately good. X-ray examination, September 18, showed patchy atrophy of many of the bones. There was no evidence of fracture of the bones of the forearm, wrist or hand.

She was next seen by me November 20, 1931, at which time, although some improvement in the condition of the hand was exhibited, this member was still practically useless. In the interval hot fomentations had been employed as the chief form of treatment. X-ray examination, which had been made October 26, showed atrophy of the bones of the carpus and hand, although the patchy character noted September 18 was no longer evident.

Examination made January 23, 1933, shows that, although some improvement has taken place in the function of the hand, the latter is still seriously disabled. Rotary movements of the forearm and movements of the wrist-joint are normal. Movements of the thumb are normal and movements of all metacarpalphalangeal joints are approximately normal. All four fingers are slightly swollen—the patient states that at times

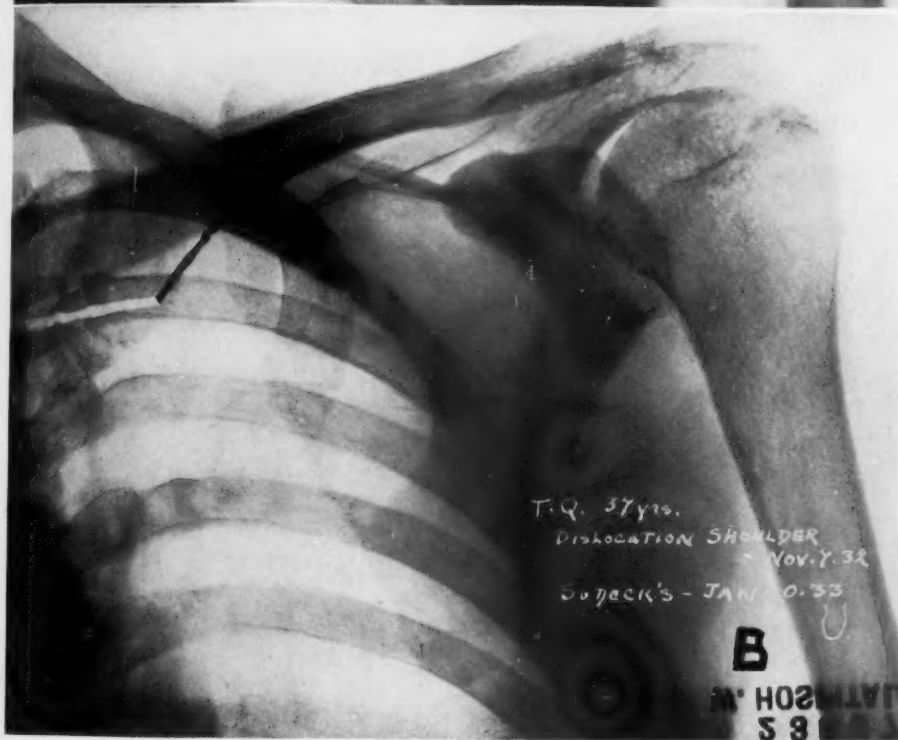
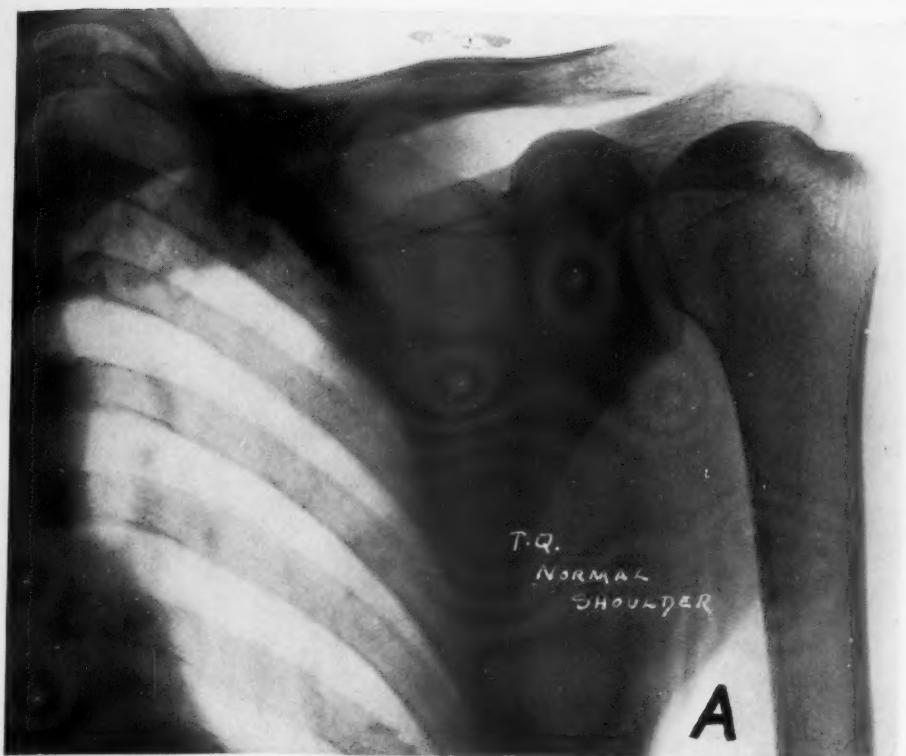


FIG. 6.—(Case XII.) (T.Q.) Röntgenograms both shoulders. (A) Normal shoulder. (B) Atrophic shoulder. Seven weeks after dislocation reduced the day of injury.

they are more swollen—and are very stiff. The distal interphalangeal joints are all incompletely fixed in slight flexion.

X-ray examination made January 23, 1933, shows that the bones have almost regained their calcareous content, although in the interval practically no activity of the hand has been employed. The only important point of interest in connection with the case was that in September, 1932, manipulation under an anaesthetic was employed.

The last case to be detailed is, perhaps, the most interesting of the series. The history of repeated insult during treatment, the typical clinical and radiological appearance and the satisfactory result of conservative treatment—diathermy and graduated function—are all, I believe, instructive.

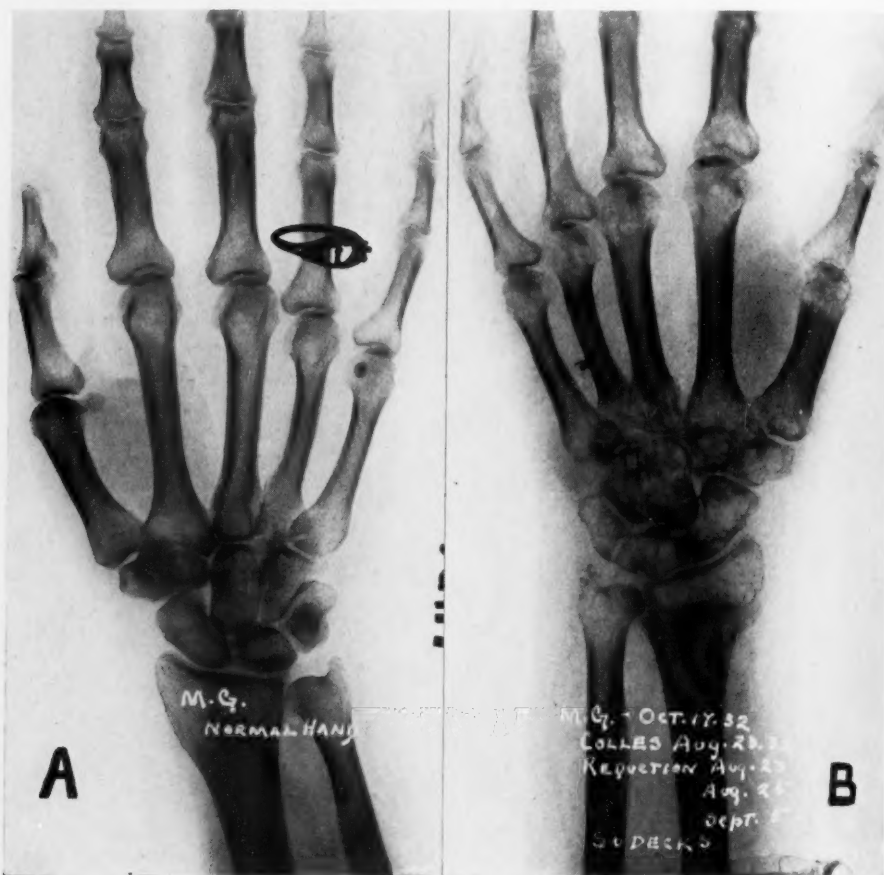


FIG. 7.—(Case X.) (M.G.) Röntgenograms both hands. (A) Normal right hand. (B) Left hand, seven weeks after Colles fracture; shows marked osteoporosis of typical patchy character.

CASE X.—Miss M. G., fifty-one years. This lady fell while on shipboard, suffering a Colles fracture of the left wrist. An immediate attempt at reduction by the ship's surgeon was carried out and the forearm fixed in splints. Three days later upon arriving at port, reduction was again attempted under local anaesthesia and plaster-of-Paris, in the form of a molded posterior splint, applied. Two weeks after injury a further attempt at reduction, under general anaesthesia, was carried out and a heavily padded circular plaster bandage applied.

The patient was first seen by me September 15, 1932, eight days after the third attempt at reduction, at which time the fingers and hand were swollen and all move-

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ments, both active and passive, of fingers and wrist were very painful. Plaster-of-Paris was re-applied without padding. The condition, however, became increasingly more painful and the limb more useless. In this respect she volunteered the information that prior to the third attempt at reduction, approximately fifteen days following injury, movements of the fingers had been free and the hand relatively painless.

X-ray examination made October 17, 1932, showed well-marked patchy bone atrophy to be present. This atrophy involved the lower end of the radius and ulna and all the carpal bones, both extremities of the metacarpal bones, and to a lesser extent, the phalanges. The joint contours were unusually distinctly shown. Union at the site of fracture of the radius appeared to have progressed satisfactorily and with but little displacement.

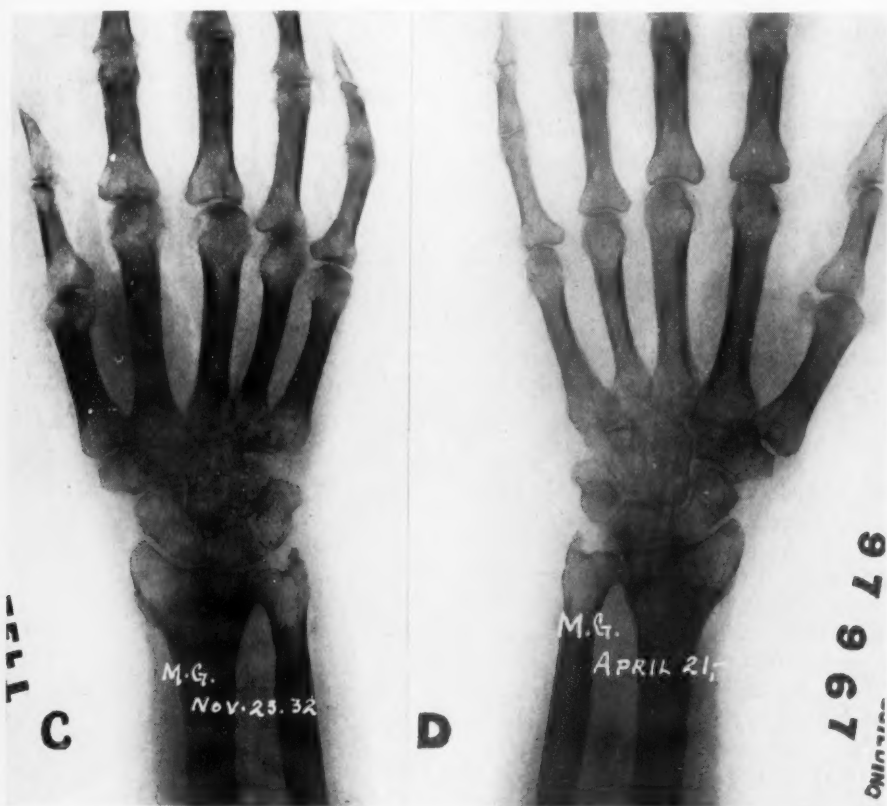


FIG. 8.—(Case X.) (M.G.) Röntgenograms of left hand. (C) Twelve weeks after injury. Diathermy, five weeks shows commencing improvement. (D) Five months after C. Diathermy; clinical cure; radiologically marked recalcification.

Plaster-of-Paris was removed October 17 and the patient instructed to avoid carrying out any movements which caused even the slightest amount of pain. Diathermy was instituted three times weekly and active movements, under instructions, short of pain.

Progress has been slow but continuous. By February 15 swelling had largely subsided and movements were all at least half normal. X-ray appearance of the bones had altered so that patchy appearance was no longer present and evidence of recalcification of the bones was seen in picture made January 17, 1933.

This case demonstrates, among other things, the fact that the development of acute bone atrophy does not appear to influence the time required for the healing of fractures.

SUMMARY.—Although a certain grade of bone atrophy occurs habitually when extremities are put at rest, such atrophy is of trivial importance. In a very small percentage of cases acute marked osteoporosis occurs within a short time following injury.

Acute bone atrophy following injury was first described by Sudeck in 1900. The condition exhibits typical clinical and radiological appearances.

Pain is a predominant factor together with extreme loss of function. Swelling and evident atrophy of the skin and subcutaneous tissue are characteristically present.

The condition follows, as a rule, more or less trivial injuries, particularly in the neighborhood of joints, and more especially in the neighborhood of ankle- and wrist-joints.

Pathological studies prove a uniform loss of bony substance and not merely a depletion of mineral salts.

The explanation for the condition would appear to be that through a stimulus of the reflex arc with consequent local hyperaemia bone absorption is brought about.

Although it would appear that the phenomena responsible for the condition are reversible, cure may require a very long period of time. In the case of the lower extremities protected weight-bearing is the most important factor in treatment. Diathermy is apparently useful and at Leriche's Clinic in Strasbourg ganglionectomy has apparently proved its usefulness.

Two tables are published. One analyzes twenty-one cases reported in detail by Fontaine and Herrmann. The other analyzes fourteen cases studied by the author. Four of the author's cases are reported in some detail.

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DISLOCATION OF THE CERVICAL VERTEBRÆ

REPORT OF A CASE OF COMPLETE FORWARD DISLOCATION OF THE SIXTH
CERVICAL VERTEBRA WITH REDUCTION BY FORCIBLE TRACTION
AND FULL RECOVERY

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OF NEW YORK, N. Y.

THE following case of complete forward dislocation, which has recently come under my own observation, is one in which full reduction of the dislocation was secured by forcible traction and counter-traction under anæsthesia without subsequent immobilization.

CASE HISTORY.—A man, aged thirty, was admitted to the Albany Hospital in the evening of March 23, 1932. When first seen by me he was standing in a peculiar ape-like posture, with head bent forward, making it necessary for him to look upward as though peering over the top of eye-glasses. The hands and arms hung forward, and the body was slightly flexed. He stated that while riding in an automobile that afternoon he had been thrown forward against the right front of the car when it skidded off the road into a telegraph pole (5 P.M.). Neither his companion, who was driving the car, nor he seemed at the time to be seriously hurt, and except for severe pain in the back of the neck, inability to turn his head comfortably and tingling sensations in his finger-tips, he had little to complain of. He had been brought to Albany in another car, a trip of twenty miles from the scene of the accident. The ride had caused so much pain at the base of his neck that he had consumed almost an entire pint of whiskey in his attempts to relieve it.

The patient was a well-built, rather heavy young man, weighing 210 pounds. General examination was negative. In addition to the abnormal posture, one could note a definite depression at the site of the sixth cervical vertebra deep enough to insert the tip of the finger. Active and passive movements of the head and neck caused marked pain. There was pronounced tenderness at the base of the neck posteriorly. Abduction of the arms was limited to the horizontal. Beyond that point pain resulted. The reflexes of the arms were apparently normal. There were paræsthesias of both hands, and diminution of tactile sensation. The hand grips were weak. Aside from these findings, all was negative.

The röntgen findings in a lateral film showed the presence of a complete dislocation of the articular facets of the sixth cervical vertebra on the seventh. The only indication of a dislocation in the antero-posterior exposure was a suspicious widening of the gap between the spinous processes of the sixth and seventh cervical vertebræ. There was no X-ray evidence of fracture of the dorsal region of the spine.

The patient was immediately put to bed and traction applied by means of a jury-mast and weights. The head of the bed was raised and ten pounds of weight applied over the top of the bedstead. This was gradually increased to twenty pounds, but the patient rebelled so strenuously that a compromise was necessary, the patient being given an hour's rest alternating with an hour of traction.

The next morning, after a night rendered sleepless by pain, he refused this method of treatment absolutely, insisting that he felt as though his lower jaw were being pushed through his head. When examination showed that nothing had been gained by these measures, the patient was offered the alternative of traction under ether, after the dangers of this course had been fully explained to him. He readily accepted, and on the fol-

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lowing morning (March 25) an attempt at reduction was accordingly made under colonic anæsthesia. This form of anæsthesia, however, did not produce sufficient relaxation, nor did the bed afford sufficient leverage for traction. The patient was therefore placed on the X-ray table with his head beyond the end of the table, and after an adequate deep inhalation anæsthesia, strong, forceful and gradually increasing traction was applied. The surgeon sat on a stool and pulled on the traction straps with his feet braced against the patient's shoulders, while at the same time two assistants employed counter-traction.

After a few minutes of this slow, steady pull, the patient's head was rotated strongly to the left and then relaxed, as a grinding snap was heard. Fluoroscopic examination



FIG. 1.

FIG. 2.

FIG. 1.—Appearance of patient with complete forward dislocation of sixth cervical vertebra.
FIG. 2.—Appearance of patient after reduction of cervical dislocation. He states that this was his normal posture before the injury.

showed partial reduction. Similar stretching and rotation to the right was then employed, until a similar snap and grating were felt. The X-ray picture at this time showed complete reduction. No form of immobilization was employed after treatment.

On recovering from anæsthesia the patient was examined for signs of spinal cord injury, with negative findings. He complained of some pain in his neck, but was able to rotate the head and neck without difficulty. The next day he could accomplish these motions with only slight discomfort and was allowed out of bed. After a few more days of observation, during which practically all pain and tenderness disappeared, he was discharged to his home on the twelfth day of hospitalization. He has been perfectly well to date. Figure 2 shows the patient after reduction of the dislocation.

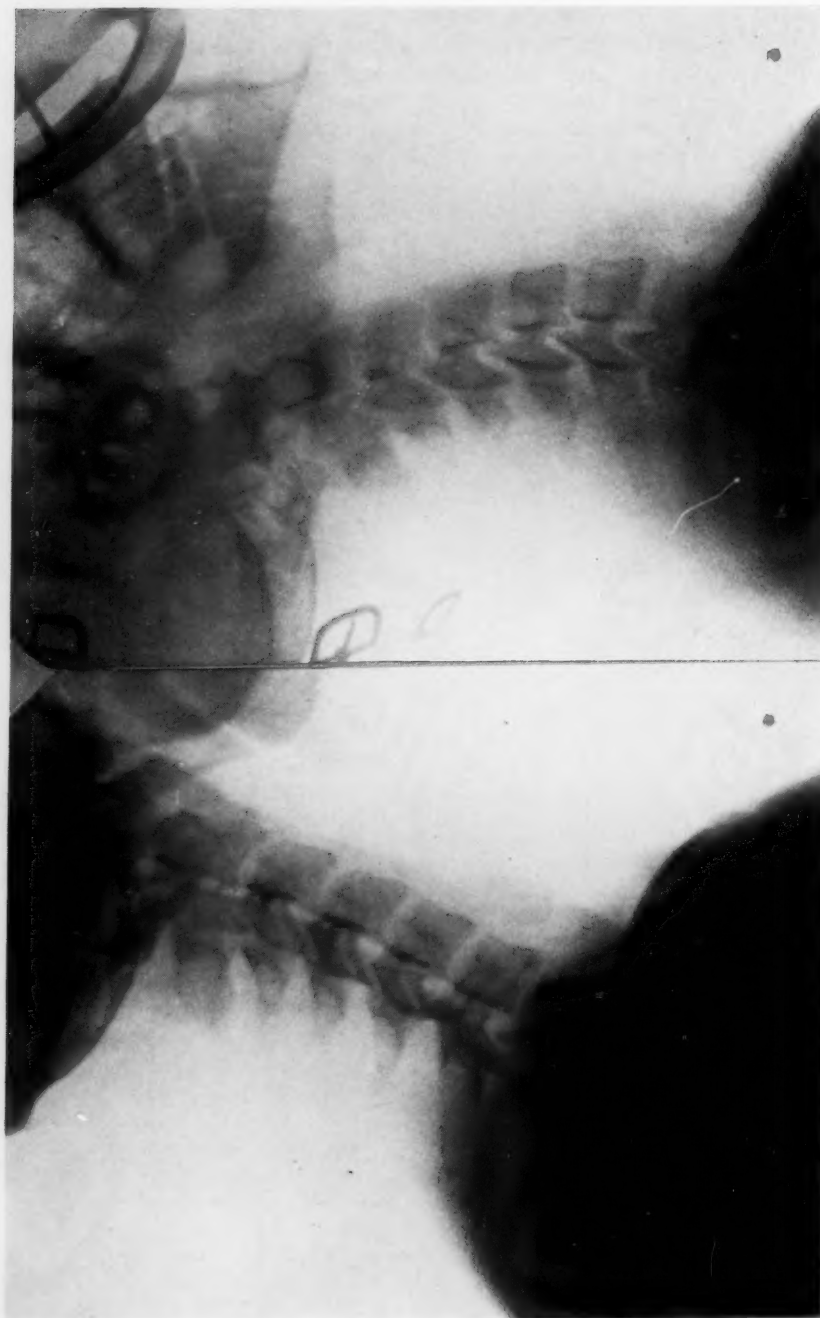


FIG. 3.

FIG. 3.—Lateral exposure. This clearly shows the presence of complete dislocation of the articular facets of the sixth cervical vertebra on the seventh. Note the projection backward and upward into the spinal canal of the posterior border of the seventh vertebral body. Note also similar displacement of the facets of the seventh cervical behind those of the sixth. The procedure necessary to reduce such displacement is shown in Fig. 4.

FIG. 4.

FIG. 4.—Lateral exposure after forcible traction under fluoroscopic control shows complete reduction of forward dislocation of sixth cervical vertebra.

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DISCUSSION.—The case is cited as representative of a hopeful type of cervical vertebra traumatism in which the cord remains uninjured, only a few peripheral nerves being involved, as expressed in the temporary paræsthesias of both arms. The sixth cervical vertebra had slipped forward on the seventh on both sides, where it hung helpless, making effective movements of the head almost impossible. It was a case of complete forward dislocation, which yielded readily to reposition by traction under general anæsthesia. The fact that the patient made a permanent recovery without any form of immobilization is a matter of some interest, in view of the prevailing view that hyperextension in some form of apparatus or plaster is necessary over a long period in cases of this kind.

In diagnosing dislocations of the cervical vertebræ, it is important that the physical examination be as complete and thorough as possible, to avoid unpleasant surprises at a later time. The diagnosis may be very easy or extremely difficult. Account must be taken of the history, the nature of the trauma, and the appearance of the patient, who frequently, as in the above case, has his head strongly bent forward and is able to move it only with difficulty. This appearance immediately suggests the presence of dislocation or fracture. In McKenna's¹¹ case the essential feature was left-sided torticollis. Binnie's¹⁶ case presented no notable deformity of the spine, but the patient was suffering acutely with cervical pain. The presence of contusions and distortions, of torticollis and lacerations, with pain upon attempting to move the neck, should always arouse suspicion of a dislocation or fracture.

The court of final appeal, however, must always be the X-ray. In no case must the negative findings of a simple antero-posterior view be trusted, for in the presence of a dislocation it is the lateral view that will show a marked deformity in the contour of the vertebral column. Langworthy,⁴ in fact, who has performed the Walton operation successfully in thirty cases, regards only the lateral view as having any value. He not only makes röntgenograms before and after reduction, but if, as frequently happens, several attempts are necessary before reduction is accomplished, he makes a fluoroscopic examination after each one. He points out, however, that unilateral cases cannot be shown in röntgenograms, these being largely rotations, with the crooked position of the head and the tilting of the chin as the chief symptoms, associated with limited lateral bending of the head. Mackinnon² emphasizes the importance, in addition, of making a vertical shift, which has the advantage of showing one or two vertebral bodies clearly above or clearly below the one under suspicion, so that an effective comparison can be made with a view to establishing the site of dislocation.

When a differential diagnosis has to be made between dislocation and fracture, errors are possible even in spite of good X-ray pictures, says Laesecke.⁷ In the cervical portion of the vertebral column, especially as a result of the protrusion of the larynx and trachea, and even more because of the many overlappings of articular and transverse processes, with their

many articular facets and small prominences, the röntgen picture offers much more possibility of false interpretation than in lower portions of the spinal column.

If cord injuries are present, there will be a paralysis of the parts whose nerve supply is compressed at the level of the cord corresponding to the dislocated vertebra.

Treatment and Results.—Steinmann¹⁷ in 1906 first reported the diagnosis of dislocation of a cervical vertebra by means of X-rays, thereby introducing a new era in the treatment of these injuries and bringing possibilities of recovery to a class of cases that had hitherto been regarded as hopeless. For, as Sommer¹ points out, it was the uncertainty of diagnosis that made great surgeons like Nelaton, Dupuytren, Richet, Desault, Porta, Bayer and Blasius refrain from reposition in order not to make bad matters worse. In the middle of the nineteenth century certain surgeons did, indeed, begin to urge active operation, but it was not until after röntgen diagnosis had become an actuality that modern surgical methods could be applied to these injuries without fear of fatal consequences.

Today the Walton¹⁸ method of reposition and the rather similar Wagner-Stolper¹⁹ procedure employed in Germany are available for every promptly diagnosed cervical vertebra dislocation.

To replace the articular facets that have slid apart, Walton conceived the idea, which he published in 1889, of bending the head first toward the right side to disengage the facets in a left-sided dislocation in order to lift the facet of the dislocated vertebra out of the intervertebral notch of the one beneath it. He then rotated the head to the left, to throw the facet backward and downward, in such a way as to make it fit onto the lower one. For the right side, in a bilateral dislocation, he did the reverse of the same process. To this method of closed reduction he gave the name of "retrolateral flexion with rotation."

In applying the Walton method, Langworthy uses the edge of his hand as a fulcrum on the opposite side of the neck from the lesion, while he bends the head laterally to disengage the facets. Since this part of the procedure requires very great force, he found that the edge of the hand on the opposite side of the neck aids in lifting the displaced facet and prevents a lateral pushing of the entire head and neck toward the shoulder, which would frustrate his efforts. After reposition, he invariably uses a plaster case to maintain the head and neck in hyperextension.

The Wagner-Stolper procedure consists of four movements: (1) a strong pull to bring about extension; (2) a slight backward push upon the dislocated vertebra; (3) a slight backward bending of the same, and (4) fixation in slight hyperextension.

In both procedures, the patient is so placed upon a table that a counter-pull can be made footward upon the shoulders by assistants, while the operator pulls in the opposite direction, his hands, placed laterally upon the head, controlling the vertebral processes with the finger-tips. The loud snap with which the displaced vertebra slips into place is characteristic, and gives assurance to the operator that he has accomplished his purpose.

Slow reduction by a Glisson sling is advocated by Laesecke in many cases. Even where there was high-grade injury to function of the spinal cord, he found that conservative treatment led to far-reaching improvement of the neurological symptoms. Hibbs²⁰ regards fusion of the articulating bones as a necessary procedure, eliminating motion and offering, in his opinion, the only chance for securing relief. The fusion is made to include at least one healthy vertebra above and one below the injured one. He reports that it has been successful in all cases in which it has been used at the New York Orthopedic Hospital.

Blasius⁸ (1869) in a series of 159 definitely diagnosed dislocations of the cervical spine collected from the literature, found thirty-six favorable and 123 fatal results, or a ratio of one case of complete or partial recovery to 4.5 cases terminating fatally. Of the thirty-six favorable cases, seven had recovered spontaneously without a physician.

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However, in cases of bilateral forward luxation, which are the most common and the most dangerous, he noted a percentage of fatalities amounting to 92.6. He cites Malgaigne²¹ (1806-1865) as having regarded unreduced bilateral dislocations as 100 per cent. fatal; and these cases were not uncommon, for in Malgaigne's day surgeons hesitated to reduce, owing to the uncertainty of diagnosis. Blasius also collected thirty-seven unreduced cases in which the time of death is mentioned, as follows: Six within twenty-four hours, fourteen in the next two days, thirteen within three to eight days, and four within ten, twelve, nineteen and seventy days respectively.

Nineteen years after Blasius made his extensive statistical study, Wagner and Stolper¹⁹ (1898) collected 205 cases, including their own, of dislocations of the lowest five cervical vertebræ. In this collection the fatalities numbered 148, and the cases cured or improved fifty-seven, a ratio of 2.6:1. As regards type of lesion, these were distributed as follows: bilateral forward dislocations 141 (118 dead, twenty-three surviving); rotation dislocations, forty-nine (eighteen dead, thirty-one surviving); backward dislocations fifteen (twelve dead, three surviving). These authors added three more to the list of seven cases recovering spontaneously. They credit Vrignonneau²² with having been the first to reduce a bilateral forward luxation.

Walton¹⁸, in 1889, reported five personal cases, two bilateral and three unilateral, in four of which treatment by traction and rotation resulted in partial or complete recovery. In the fifth case, which was a bilateral dislocation of the fourth cervical vertebra, the patient did not come to the hospital until two months after the accident, and reduction accordingly failed; he became helpless for fifteen months, then suddenly, in the bathtub, felt a sensation like an electric shock, as the displaced vertebra slipped spontaneously into place. Recovery was complete, and the patient was able to resume work within a month.

Quetsch⁹ (1914), had eight bilateral cases, which he reduced successfully by the Wagner-Stolper method. In seven of these there were cord injuries, which recovered in the course of time. In five other cases the patients were left permanently with limited motion of the head.

Meyer²³ (1914), reporting a case of complete dislocation in which there was full recovery after reduction by the Wagner-Stolper method, expressed the belief that the spinal cord does not nearly fill the entire cavity of the spinal column, and that it can consequently bear considerable pressure before it becomes compressed, thus accounting for the possibility of such cures.

Of the thirty personal cases which Langworthy⁴ (1930) has successfully reduced by the Walton method, seventeen were bilateral and thirteen unilateral. All the unilateral cases ended in complete recovery. Of the seventeen bilateral cases, twelve recovered; in one of the twelve, there was redislocation ten weeks later; reduction was again done, this time with recovery. In eight of the seventeen cases, there were severe cord injuries and in five of these death occurred after reduction had been accomplished, thus making a mortality of 30 per cent. in bilateral cases—in strong contrast to the 92.6 per cent. in Blasius' day.

Ployé,¹⁰ who reduced three unilateral dislocations in less than a month, found that kelene local anæsthesia produced such complete relaxation that there was complete muscular resolution, making reduction so easy that the patients returned to work after two days.

Prognosis.—Because of the frequency of severe cord injuries, complete dislocations as a rule have an unfavorable prognosis, though less so than formerly. Luxation of the four uppermost vertebræ often paralyzes respiration and is therefore immediately fatal. Baur¹³ has reported a case of this kind, in which all the first four vertebræ were dislocated upon the fifth. The cord function was irremediably compromised and the case terminated fatally on the day following the injury. In asphyxial conditions reposition executed promptly enough may succeed in relieving the respiratory disturbance. Steinmann¹⁷ in 1906 collected twenty cases of complete luxation of cervical vertebræ in the

literature, in patients who lived on after their accident. Meyer²³ in 1914 collected thirty-one cases that had survived. Langworthy⁴ reports that he has found lesions in the upper and lower cervical vertebræ are equally dangerous.

When cord injuries are present, paralysis may persist for a time, yet clear up later if there has been only simple compression from hæmorrhage. Sommer asserts that the most important disturbances remaining are of a static nature, consisting of motor disturbances and decreased capacity for carrying burdens. While these are less in the cervical than in the dorsal and lumbar vertebræ, they nevertheless cause in elderly persons a strong forward bend of the head, followed by ankylosing spondylarthritis and diminished mobility. Young individuals can compensate the dislocation better by lordosis, because of greater elasticity.

According to Elsberg²⁴ there are cases of spinal injury in which the symptoms at first are those of complete transverse spinal lesion, but in which after the expiration of days, weeks or months a considerable or perhaps complete return of power and sensation occurs. He maintains that in cervical and dorsal injuries with transverse cord symptoms an operation should never be performed until distinct and definite signs of returning sensation and reflexes give proof that part of the transverse diameter of the cord is intact. In partial lesions of the cord, however, he regards the problem as entirely different. If the injury has not been severe enough to interfere with all the cord functions, then pressure by dislocated or fractured bone may be contributing to the symptoms, and relief by a wide decompressive laminectomy is certain to be of great benefit.

Taylor²⁵ did a hemilaminectomy in a case of fracture-dislocation between the fifth and sixth cervical vertebræ, relieving the patient of all symptoms but a typical left ulnar paralysis. Another case of Taylor's was completely restored by traction.

Where no cord injuries exist, the dislocation can frequently be reduced, as in the case here reported. The sooner this is done, the better the prognosis. McKenna²¹ regards reduction as difficult after the tenth day, even under an anæsthetic, and holds that in three to six weeks the displaced vertebræ are so fixed that the task is impossible. Bony and fibrous adhesions form, which may sometimes be improved by open operation, as in de Quervain's²⁴ two cases of old dislocations in which he did an autoplasty, using the scapula, with excellent results.

Of all the vertebræ in the entire spine, the six lower cervical exhibit the greatest tendency to undergo dislocation, especially that pure type of luxation which is unaccompanied by simultaneous fracture.

There are very good anatomical reasons why this should be the case. The atlas, as Sommer¹ has pointed out, is held in place by powerful muscular bands. The ribs exert an effective control over the dorsal vertebræ, binding them into a compact column, difficult to interrupt. The lumbar vertebræ are bound together into an almost impregnable piece of masonry, and will fracture before they will dislocate. Any dislocations occurring here as the result of severe blows are practically always associated with fractures.

The six lower cervical vertebræ, on the contrary, are always exposed to the danger of dislocation by the very fact that they are designed to give mobility to the head. Their principal protection is the strong musculature of the neck and shoulders, in the powerful ligamentum nuchæ, but this is by no means invincible: Its resistance can be broken down by a blow appropriately directed upon the skull and reflected upon the vertebræ.

"If we remember," says Sommer, "that the cervical vertebræ are so-to-say based upon the dorsal vertebræ belonging to the the back, and that all move-

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ments of the head are for the most part accompanied by movements of the cervical vertebræ against the back, so that when violence is inflicted upon the head, these vertebræ bear the brunt of the blow, we can readily see that it is here that dislocations must occur with relative frequency. Then if we add to this the anatomic peculiarities of the cervical vertebræ, the relation of height to breadth, the high intervertebral disks, the oblique position of the joint surfaces, the labile displaceability upon the vertebral disks which serve as cushions to give the vertebræ their ready mobility, but which yet predispose to a separation of the articular facets from one another upon exaggerated motion, it becomes evident that bony restraint and protection are entirely wanting."

A glance over the literature reveals that the fifth cervical vertebra stands first in order of frequency of dislocation, the sixth second, with the fourth and third next in about equal incidence. Mackinnon² in twelve cases, involving twenty-two cervical vertebræ, found one dislocation of the second, three of the third, four of the fourth, seven of the fifth, six of the sixth, and one of the seventh. Blasius³ in a collection of eighty-four cases found the second dislocated eight times, the third thirteen times, the fourth twelve times, the fifth twenty-four times, the sixth twenty times, and the seventh seven times. Langworthy⁴ among seventeen bilateral cases of cervical dislocation had six luxations of the fifth, and three each of the second, fourth and sixth vertebræ. Bobrecker⁵ confirmed the figures of Blasius, while Kocher⁶ gave the chief place to the sixth, reporting two of the fifth, nine of the sixth and two of the seventh. In the last five years Laesecke⁷ has had two dislocations of the sixth upon the seventh, two of the fifth upon the sixth, one of the fourth and fifth together, and one of the third.

According to Feistkorn⁸ the sixth cervical vertebra is especially disposed to dislocation through its small breadth in proportion to height, the peculiar elasticity of its intervertebral cartilage and the obliquity of its articular surface.

Dislocations of the cervical vertebræ are rather more common than was supposed prior to the diagnostic use of the X-rays. From the cases reported there is no reason to believe that they have gained in frequency, as is sometimes asserted in view of the multiplicity of automobile accidents, but only that the röntgen rays have made their detection easier, so that cases that would formerly have remained undiagnosed are now recognized with comparatively little difficulty. Quetsch⁹ stated twenty years ago that serious dislocations had been overlooked by physicians who observed nothing beyond muscle contusion. That these injuries are not altogether rare is proved by the fact that in nine years of private practice Langworthy had thirty cases, of which seventeen were bilateral and thirteen unilateral. Laesecke⁷ has reduced nine fractures of the cervical portion of the spine, four of which were accompanied by dislocations. Ployé¹⁰ has recently reported three cases of mediocervical subluxations observed in a single month in the Maritime Hospital of Cherbourg.

The mechanism of these dislocations appears to be a sudden blow inflicted upon the head at a moment when the neck is partly flexed. Thus Mackinnon² reports three cases due to a fall, alighting on the head, three in which the victim was thrown from an automobile or plow, one from diving into shallow water, others from blows on the head, the sandwiching of an individual between two handcars, and from being run over while in a doubled-up position. It is not uncommon, says this author, for such injuries to result from a very slight trauma. McKenna¹¹ says they may result from any sudden jerk. Sweaney¹² and Baur¹³ have reported cervical dislocations from football injuries. Feistkorn's⁸ case was that of a man who fell with his head bent backward in a wrestling match.

Whatever the cause of the trauma, the effect upon the vertebra struck is to make it slide upward on the facet of the one lying beneath it and, catching on top of this, to remain locked in its unnatural position; or it may slip completely over into the intervertebral notch in front of the lower facet. In either case the patient's head is suddenly rendered immovable or nearly so, the loss of function, according to de Quervain,¹⁴ being worse than in fractures. The dislocation may be bilateral (complete) or unilateral (partial); it may be forward or backward; or it may be a torsion dislocation of the atlas, as in Brookes and Ewerhardt's¹⁵ case. Luxation toward the front, according to Feistkorn,⁸ aside from the effect of the direct blow, is due to excessive curvature; luxation toward the back, to overstraining; and rotation luxation, to exaggerated turning of the vertebra.

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OSTEOCHONDROMATOSIS OF ELBOW

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OSTEOCHONDROMATOSIS of the elbow is of very great interest to the surgeon from several important aspects. Firstly, the condition of osteochondromatosis, referring to the occurrence or accumulation in joints, bursæ, or tendon sheaths of small or large numbers of loose osteochondral bodies, is comparatively rare. With few exceptions no one surgeon is likely to see more than a half-dozen instances in his whole career. Secondly, the origin, development, pathology and the etiology are all in doubt. Thirdly, the pathology is such as, at times, to interfere with or even preclude complete surgical cure. Because of these facts it seems worth while to report in detail several cases, with a critical review of their salient features. There is a special interest in my group in that two of the patients had a bilateral lesion of the elbow-joints, a circumstance that has so far not been recorded in the literature.

CASE I.—Osteochondromatosis of the Right Elbow.—Israel K., forty-seven years old, was referred to me in February, 1931, for pain in, and disability of, his right elbow. This patient was a pushcart peddler. While he had to do much lifting of moderately heavy objects, he had been accustomed to such work for many years, he used both arms with equal force, and he recalled no occasion at which he had strained or injured the right elbow. Two years previously he noticed a gradually increasing flexion contraction of the right elbow. During the six weeks immediately preceding my first examination, the elbow became painful, there was a decided reduction in extension of the elbow, and forced extension aggravated the pain. He was a well-built, muscular, healthy-looking individual. He had no abnormalities anywhere except in the right elbow.

Right Elbow.—This joint appeared normal. The range of movement extended from 60° of flexion to 120° of extension. Rotation of the forearm was entirely free. There was no local heat or tenderness to pressure. There was no motor, sensory or vascular disturbance in the forearm or hand. The lateral röntgenogram (Fig. 1) showed a large number of free bodies, small and large, located in the front of the elbow. There were also several loose bodies posteriorly in the olecranon fossa. This is not clearly seen in the print here reproduced. The diagnosis of osteochondromatosis was evident and an operation for the removal of the loose bodies was advised.

Operation—February 20, 1931.—The approach to the elbow which I used here was designed to give easy access without injuring tissues and with practically no bleeding. A vertical incision was made on the front of the elbow somewhat lateral to the median line. The biceps tendon was retracted inward and the brachio-radialis muscle outward, exposing the brachialis anticus. The fibres of the latter muscle were separated laterally, bringing the capsule of the joint immediately into view. The capsule was incised vertically, affording a good view of the anterior compartment of the joint. About two dozen osteochondral loose bodies were removed. Some of these were attached to the synovial lining of the capsule. The bodies varied in shape and in size from one-eighth to one-half inch in diameter. They were, many of them, tucked away in various recesses of the joint, so that some maneuvering was necessary to dislodge them. When I was

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through, the front of the joint appeared free of any loose bodies. At this juncture flexion of the elbow was practically normal but extension was still markedly restricted. I, therefore, concluded that extension was obstructed by some loose bodies in the olecranon fossa. Accordingly, an incision was made on the back of the elbow and several large bodies were dislodged. The wounds were closed in layers and healed by primary union. Even after the removal of the bodies from the posterior compartment complete extension was impossible. The restriction was believed to be the result of contraction of the anterior capsule of the joint.

The patient made an uneventful recovery from the operation. At first the range of movements of the elbow was somewhat less than before the operation, but this soon increased. When last seen in April, 1932, the patient expressed himself as satisfied with the operation because he was not only able to work, but could lift heavy objects, and had very little discomfort. The gain in the movement of the elbow was comparatively



FIG. 1.—(Case I.) Lateral pre-operative roentgenogram. Note numerous loose osteochondral bodies in the anterior compartment of the elbow. There are several loose bodies in the posterior compartment or olecranon fossa; the arrow points to their location. They are not clearly visualized in this view, but show up plainly in the antero-posterior film. There is no evidence of any joint irregularity or osteophytes, that is, there is no associated arthritis.

small. Flexion was unaltered. Extension, which had been limited to 120° , was now possible to an angle of 140° , a gain of 20° .

Comment.—The small gain in joint function was disappointing and due evidently to the fact that some loose osteochondral bodies had been left in the elbow. Although at the time of operation I was certain that I had removed all the loose bodies, I had actually failed to do so. A post-operative roentgenogram showed several bodies, some of considerable size, that had been left behind in the anterior joint compartment. These bodies must have been walled off by intra-articular adhesions of the synovial membrane. I recall distinctly that the synovia was thickened and formed cells or compartments. The articular cartilage grossly seemed unimpaired. There were no osteophytes. The bodies removed had a central core of bone covered with cartilage.

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CASE II.—*Osteochondromatosis of Both Elbows*.—George F., forty-one years old, was seen in my out-patient clinic at the Hospital for Joint Diseases. His chief complaint was pain in both elbows which had begun to trouble him two years previously. The patient was a laborer who worked with a pneumatic hand drill. His upper limbs were, therefore, subjected to severe jarring during his work. At times the drill would slip and he felt a shock in his elbows. One year ago he injured his left elbow while playing soccer. The condition of his elbows became aggravated so that when I first saw him he was unable to bring his hands to his face, and, in addition, had numbness in the right small finger. He was in good general condition with no lesion anywhere except in his elbows and the right hand.

Right Elbow.—This joint was markedly limited in its movements; extension was checked at an angle of 165° , and flexion at a right angle; rotation of the forearm was free. Movement of the elbow was accompanied by marked crepitus; forced motion was painful. The right hand presented atrophy of the interosseous spaces and a flexion contraction of the little finger at the proximal interphalangeal joint. There was also diminu-

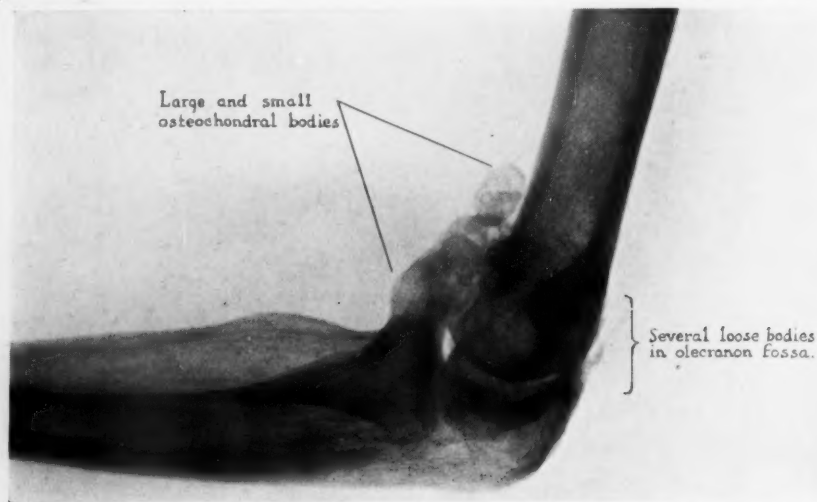


FIG. 2.—(Case II.) Lateral roentgenogram of right elbow. Left elbow shows similar lesion. There are seen numerous bodies of varying sizes in both the anterior and posterior compartments of the elbow. The articular cartilages are clear, and there is no roughening of bone at the articular junctions, so that there is no sign of any arthritis.

tion in the sensory function of the little finger. There was, therefore, paralysis of the ulnar nerve.

Left Elbow.—This joint showed greater restriction of its movements than the right elbow. Extension was possible only to an angle of 140° , and flexion to 90° ; rotation was free. Crepitus was present during all movements. There was no atrophy of the hand and no disturbance of its motor or sensory functions.

The X-ray pictures of the elbows showed similar lesions. In the lateral view of the right elbow (Fig. 2) here reproduced it is seen that there were numerous loose and attached bodies in the anterior compartment and several bodies in the back of the elbow.

This patient evidently had an osteochondromatosis of both elbows with the formation of many joint bodies which were mechanically reducing the function of both joints to an increasingly serious degree. In the right hand there was a secondary ulnar paralysis. Consequently, it was decided to operate on both elbows for the purpose of removing the obstructing bodies from within the joints.

January 24, 1930.—The left elbow joint was exposed through a posterior incision. Numerous bony masses were found attached to the posterior surface of the humerus

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and to the olecranon process. None of them was entirely loose; some were attached by narrow pedicles. They were all removed. The synovial tissue was found to be thickened and was excised. Similarly, several large bodies which were attached to the humerus in the anterior compartment of the elbow were removed together with much thickened synovia. The microscopical examination showed an extensive villous proliferative synovitis. Many of the bony masses were covered with cartilage that had eroded areas.

Right Elbow Operated on June 27, 1930.—The right elbow-joint was exposed through lateral incisions. Nine bodies were removed from the anterior compartment. Some of them were loose, others were attached to the front of the humerus and to the coronoid process, while still others were loosely held in the radiohumeral recess. At

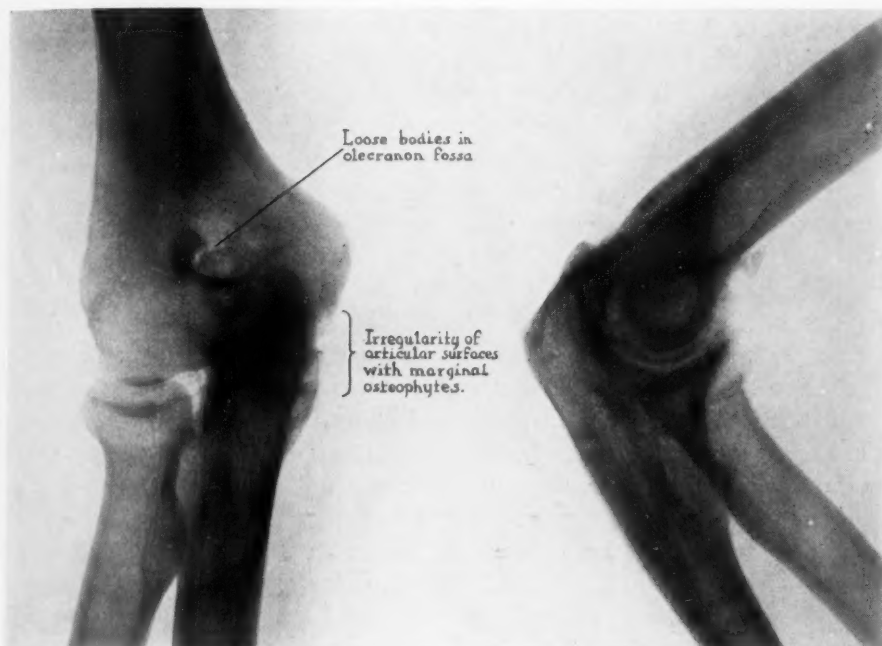


FIG. 3.—(Case III.) Right elbow. Note loose and attached joint bodies in the anterior compartment and the olecranon fossa. The articular margins on the inner side of the joint are irregular due to a hypertrophic arthritis. This is seen very clearly in the original films. The articular cartilage itself is not altered.

this stage of the operation the elbow could be flexed perfectly and extended to 170° . The removed bodies consisted of cartilage with bone cores.

This patient was seen in my follow-up clinic several months ago. He felt quite pleased as he had a distinct increase in the range of movement in both elbows, the pain had subsided and he was able to use his arms, elbows and hands with much greater freedom.

CASE III.—Osteochondromatosis of Both Elbows.—Charles A., forty years old, consulted me a year ago for stiffness in both elbows and numbness in the fingers of the right hand. Three and one-half years ago he injured his right elbow while playing handball. He had a "kink" in the elbow but the peculiar sensation disappeared and he paid no further attention to it. Some months later he began to feel some stiffness in this joint. More recently the elbow became painful and the little and ring fingers numb. The left elbow began to trouble him also several years ago, the chief difficulty being stiffness.

Examination revealed the following findings:

Right Upper Limb.—At the elbow flexion is checked at 60° and extension at 120° . Pronation is free; supination is slightly restricted. Extension is moderately painful. There is numbness in the small finger and the ulnar side of the ring finger. There are no motor or trophic disturbances.

Left Upper Extremity.—At the elbow-joint flexion is possible to an angle of 50° , and extension to 150° . Forced motion is painful. There are no sensory, motor or trophic lesions.

The X-ray picture of the right elbow (Fig. 3) shows several loose bodies in the joint. There is, in addition, narrowing of the joint space and irregularity of the articular surfaces, especially on the inner side of the elbow and along the anterior surface of the humerus, indicating the co-existence of a hypertrophic arthritis. The picture of the left elbow shows the same type of lesion.

This patient refused operation so that we have no pathological material for gross or microscopical investigation.

Discussion.—There are here recorded three cases of osteochondromatosis of the elbow-joint. All the patients were males, of particularly strong physique, their ages varying from forty to forty-seven years. The most notable characteristic is that two of the cases had a bilateral lesion. This has not previously been observed, or at any rate not reported in the literature. In both these cases the elbows were involved to the same degree. In addition, both patients had unilateral ulnar paralysis.

The etiology in my cases, as in practically all others, is obscure. A history of some form of trauma appears in about half of the cases. In two of my patients, Cases I and II, the occupation was such as to subject the elbows to frequent minor and occasional severe injuries. In the second case the man used a pneumatic drill. It was, therefore, inevitable that the elbows should suffer prolonged mild irritation and an occasional marked trauma. But my third case had a very advanced bilateral osteochondromatosis without any injury. And even in the first case there was no direct damage to the right elbow. The man was a laborer, doing hard work, to which he was accustomed. Furthermore, although he used both arms equally, only the right elbow developed signs of osteochondromatosis. It appears to me more reasonable to believe that the lesion occurs on an embryological basis. We may logically assume in these patients a susceptibility to the formation of osteochondral bodies through the presence in the synovial capsule of aberrant mesenchymal rests. These rests or chondrogenous islands are stimulated by some agency, perhaps in some cases trauma is the agency, to growth and transformation into cartilaginous or osteocartilaginous bodies. In my third case the presence of a hypertrophic arthritis indicated the existence of an irritative process of which the osteochondromatosis was one manifestation.

In all the cases I have ever operated upon the synovial lining was greatly thickened and there was no involvement of the articular cartilage. There were many villi, some sessile and others with slender pedicles. These villi are the outgrowths of the mesenchymal rests, and ultimately give rise to the osteochondral bodies, some of which are loose, and others still attached to the synovial lining. The osseous deposit in the centre of the joint body is an end-product of the metamorphosis of the synovial villus. The term

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synovial osteochondromatosis, initiated by Henderson of The Mayo Clinic, is, from the point of view of the genesis of the joint bodies, entirely correct, as it indicates the primary site of the pathological change. The theory of the synovial origin of osteochondromatosis is tenable even in my third case in which there is a hypertrophic arthritis. For in the lateral röntgenogram is visible a hypertrophic process on the front of the humerus at some distance from the articulation. Here, one may readily believe, the lesion started as a hypertrophic villous synovitis, with conversion of some of the villi into bone, at least one of which appears to have broken loose.

The clinical picture in my patients, as in most others, appeared insidiously with a sense of stiffness in the elbow. There was no single precipitating factor. Discomfort in the elbow was experienced at the start only at the extremes of flexion and extension. In the later stages pain in the joint was pronounced, especially in attempts at forced movements. The stiffness gradually increased until the motions of the elbow were seriously restricted and the joint function hampered, resulting in disability.

As the disturbance in the function of the elbow in osteochondromatosis arises from the mechanical interference with its free motion, the treatment is necessarily entirely surgical. One must remove all, or as many as possible, of the joint bodies, loose and attached. The result may be perfect. If one encounters the difficulties present in my cases there will be only partial relief. The latter eventuality is not surprising if one bears in mind the facts that the disease is essentially a synovial lesion, and it is not possible to completely excise the synovial lining of the elbow-joint, and that some of the joint bodies may be tucked away in completely walled-off recesses. After the operative wound was healed the return of function may be materially enhanced by the judicious prolonged application of physiotherapy including gradually increased motion.

CONCLUSIONS

(1) Osteochondromatosis of the elbow is primarily a disease of the synovial lining membrane.

(2) Its origin may be attributed to the presence in the synovia of rests or islands of chondrogenous cells. While this embryological concept is theoretical, it seems to be the most likely of the various potential causes.

(3) Trauma occurs in more than half of the cases, but is only a contributory factor and not an active causative agent.

(4) Two of my cases showed a bilateral lesion.

(5) A surgical approach was described giving access to the elbow with the minimum of injury to the tissues and without any hæmorrhage.

(6) In cases with marked hypertrophy of the synovial membrane the restriction of joint motion and function cannot be cured by the removal of the osteochondral loose bodies.

(7) Operative treatment, however, by removing the main impediments to joint mobility, always results in improvement and should be applied early.

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(8) Physiotherapy is an important aid in the post-operative treatment favoring a rapid recovery of the maximum function.

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RADIAL PARALYSIS COMPLICATING FRACTURE AND DISLOCATION IN THE UPPER LIMB

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THE radial nerve may be injured in a number of ways. In open wounds it may be sectioned, lacerated or bruised. In dislocation of the shoulder-joint the radial may be stretched and contused. With a lesion of this type however, there is practically always associated injury to other branches of the brachial plexus. Pressure neuritis of the radial is occasionally seen due to constant pressure for a given time against the nerve in sleep, intoxication, and peculiar posture. The nerve may also be damaged in association with fracture of the humerus and fracture and dislocation about the elbow-joint.

In this paper we are interested in radial paralysis complicating fractures and dislocations of the upper limb. A review of the literature reveals many reports on individual cases. The discussions of Lewis and Miller,² Scudder,³ Platt,⁴ Lewis¹ and others⁵ are instructive and present a rational viewpoint in the treatment of such cases. Two types of radial paralysis are seen in association with fractures of the humerus and fracture and dislocation about the elbow-joint. The primary type includes cases with paralysis caused by impact against the nerve at the time of the blow. The secondary type of radial paralysis is manifested several days or weeks after the accident and it is brought about by callus inclusion and scar tissue contraction about the nerve in the process of healing. In the majority of the cases however, it is difficult to determine the time of appearance of disability due to lack of proper neurological examination.

The radial is the most common nerve injured in fractures and dislocations. The thorough review by Lewis and Miller² shows that in 253 cases of fracture complicated by nerve involvement 136 had radial paralysis. Scudder³ estimated that there are varying degrees of radial paralysis in approximately 4-7 per cent. of the cases with fracture of the humerus. Platt's⁴ group showed a frequency of 5 per cent. In our own series of sixteen, fourteen of the cases occurred in the receiving hospital in a period of two and a half years. During this period there were 392 cases of fracture of the humerus admitted to the hospital. The percentage in this hospital is therefore between three and four, although it is very possible that some minor cases of radial palsy showing improvement within a few days are not included in this series. Were every case of humeral fracture tested out for radial dysfunction the number would undoubtedly be higher.

The frequency of radial nerve involvement in fractures can be easily understood when one considers the fact that through at least a third of its course down the arm it is in apposition to bone. As has been well brought out, the nerve may be injured at the time of the accident by stretching, bruising, by being caught between fragments. It may even be actually severed, and this was the case in thirteen out of forty-four patients with primary paralysis of radial nerve (Lewis and Miller²). The nerve may be injured by unnecessary manipulations for an anatomical result.

In one case in this series a patient entered with no paralysis and in view of poor position of fragments he was manipulated under the fluoroscope. After this manipulation he had a definite radial paralysis. In a certain number in this series the injury was evident only after several days or weeks following the accident. This emphasizes the importance of considering fracture cases a potential source of nerve injury. It should not take longer than thirty seconds to tell whether the patient has a certain nerve involvement. Such simple requests as: move your fingers; move the hand back; do you have any numbness in your hand, *etc.*, will enable the examiner to rule out a nerve injury.

In the papers consulted it is the consensus of opinion that radial palsy complicating fracture of the upper limb should be conservatively treated for a period of about three months. If by the end of this probationary period there are no evidences of returning function, the nerve should be explored at the site of fracture and treated according to pathological findings. Longer periods of conservative treatment may cause irreparable damage to the nerve. This is an accepted opinion. It is probably true that in the majority of the cases waiting for three months would not materially alter the status of regeneration of the radial nerve. However, were it possible to tell which case would require ultimate operative intervention, the best policy would undoubtedly be earliest intervention compatible with careful work. For it is true that early operation will invariably shorten the period of disability. We feel that patients with radial palsy complicating fractures of the upper limb should be given individual attention and treatment rather than be treated according to an unbending law or dictum. If cases are individually studied and if certain findings are on hand, the conclusion of earlier intervention is sane and denotes the shortening of the period of disability and the latter is of great economic importance in the majority.

SYNOPSIS OF CASES OF RADIAL PARALYSIS FOLLOWING FRACTURE OR DISLOCATION OF UPPER LIMB TREATED BY OPERATION

CASE I.—J. R., aged twenty-eight. Etiology—Bullet. Site of fracture—Junction of upper and middle thirds. Indications for operation—Radial level of triceps nerve supply. No evidence of return of function. Time between accident and operation—Fourteen weeks. Operative findings—Nerve bound down at entrance to radial groove. Spicules of bone and scar tissue compressing. Good result. Period of total disability—Forty-eight weeks.

CASE II.—S. H., aged thirty-seven. Etiology—Fall. Site of fracture—Middle third; excellent position. Indications for operation—Radial palsy (Fig. 1) with increasing

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severity the last four weeks. Time between accident and operation—Thirteen weeks. Operative findings—Neuromatous enlargement at site of trauma (Fig. 2); beginning atrophy of distal portion of nerve. Neurolysis sufficient. Good result. Period of total disability—Forty-five weeks.

CASE III.—J. R., aged three. Etiology—Fall. Site of fracture—Supracondylar. Indications for operation—Radial palsy with increasing severity. Time between accident

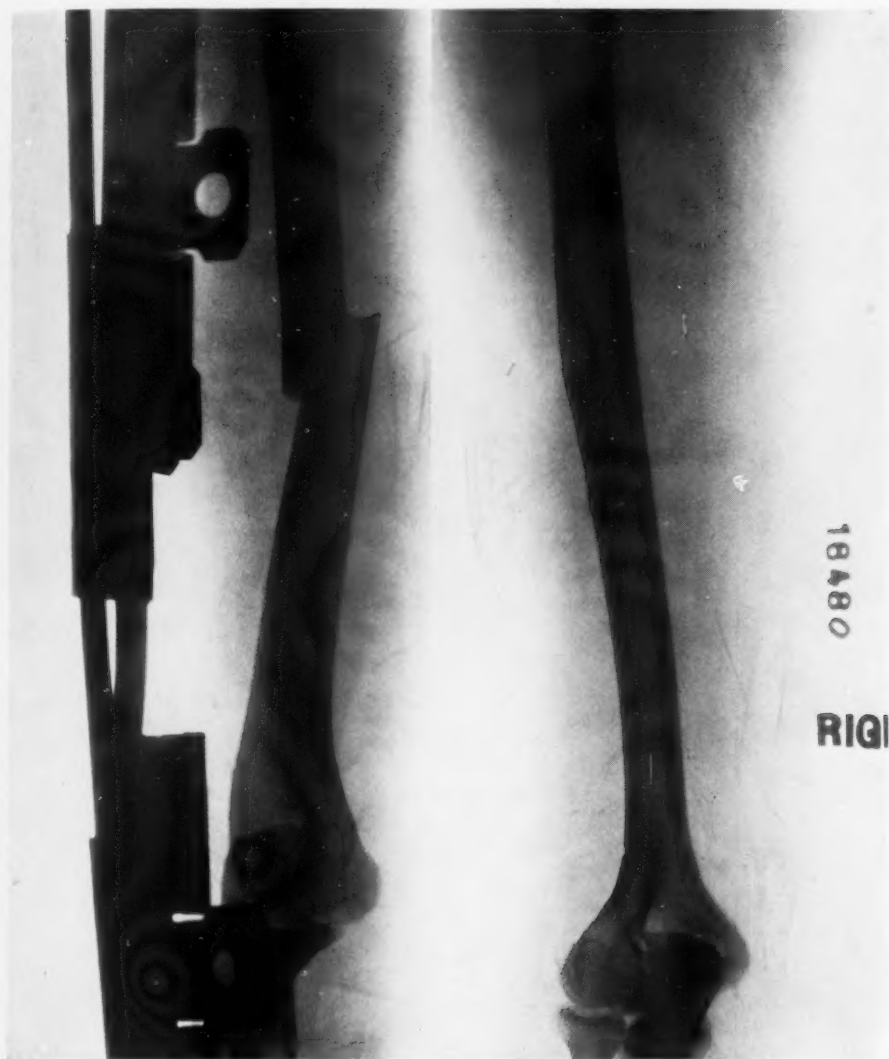


FIG. 1.—Films of Case II to show fracture of the middle third of the humerus associated with radial palsy. The latter was due to neuromatous degeneration of the nerve at the site of fracture. Even though the bone may heal in perfect anatomical alignment, this is not an argument in favor of conservatism.

and operation—Thirteen weeks. Operative findings—Nerve bound down to bone with spicules of bone in the meshes of scar tissue. Good result. Period of total disability—Eighteen weeks.

CASE IV.—J. M., aged thirty-six. Etiology—Auto. Site of fracture—Middle third; excellent position. Indications for operation—Radial palsy with no evidences of return in function. Time between accident and operation—Eleven weeks. Operative findings—

Nerve found traversing a bony and scar tissue canal. Good result. Period of total disability—Sixteen weeks.

CASE V.—G. B., aged twenty-one. Etiology—Auto. Site of fracture—Junction, middle and lower thirds. Indications for operation—Radial palsy with no evidences of return. Non-union. Time between accident and operation—Eleven weeks. Operative findings—Nerve found in much scar tissue at site of non-union, neuromatous enlargement. Good result. Period of total disability—Fifty weeks.

CASE VI.*—J. D., aged four. Etiology—Burn; no fracture. Indications for operation—Increasing radial nerve palsy. A true secondary nerve paralysis. Time between accident and operation—Fourteen weeks. Operative findings—Scar tissue contraction

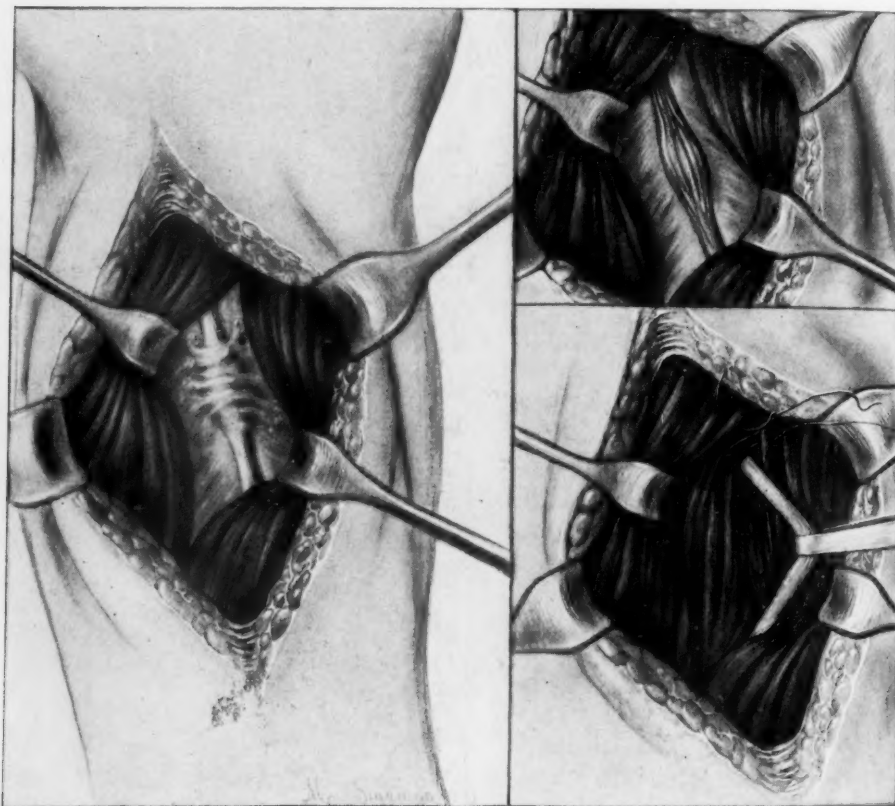


FIG. 2.—This is to show the operative findings in Case II. Grossly there was an enlargement at the site of fracture. Neurolysis disclosed swollen nerve bundles traversing the area of pathology. It was therefore thought advisable not to resect this portion of the nerve. Complete recovery ensued.

of radial at entrance into radial groove. Good result. Period of total disability—Sixteen weeks.

CASE VII.—C. S., aged forty-three. Etiology—Auto. Site of fracture—Old fracture of ulna and anterior dislocation of radius. Indications for operation—Radial palsy and old anterior dislocation of radial head. Time between accident and operation—Ten weeks. Operative findings—Nerve pushed forward by the head of the radius (Fig. 3) in the meshes of delicate scar tissue.

* This case is included in the series as an example of true secondary radial palsy. Patient had third-degree burns on the posterior aspect of shoulder and arm. At first there were no evidences of radial dysfunction. Within ten weeks a beginning radial palsy became progressively worse, until the nerve was freed and transposed into a live muscle bed.

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CASE VIII.—C. J., aged forty-one. Etiology—Bullet. Site of fracture—Supracondylar; bullet on the medial aspect of arm near shoulder-joint. Indications for operation—Radial palsy, also evidences of dysfunction of median, musculocutaneous and medial antibrachial cutaneous nerves. Time between accident and operation—Six weeks. Operative findings—Radial nerve bound down by delicate scar tissue. Bullet found in the substance of median and also compressing on the other nerves. Good result. Period of total disability—Twenty-one weeks.

CASE IX.—E. M., aged twenty. Etiology—Auto. Supracondylar fracture. Indications for operation—Open reduction elsewhere. Radial palsy and excessive callus formation. Nails in bone. Time between accident and operation—Seven weeks. Operative findings—Nerve bound down by scar tissue and callus. Good result. Period of total disability—Twenty-two weeks.

CASE X.—S. T., aged fourteen. Etiology—Auto. Site of fracture—Junction of middle and lower thirds. Indications for operations—Radial palsy following manip-

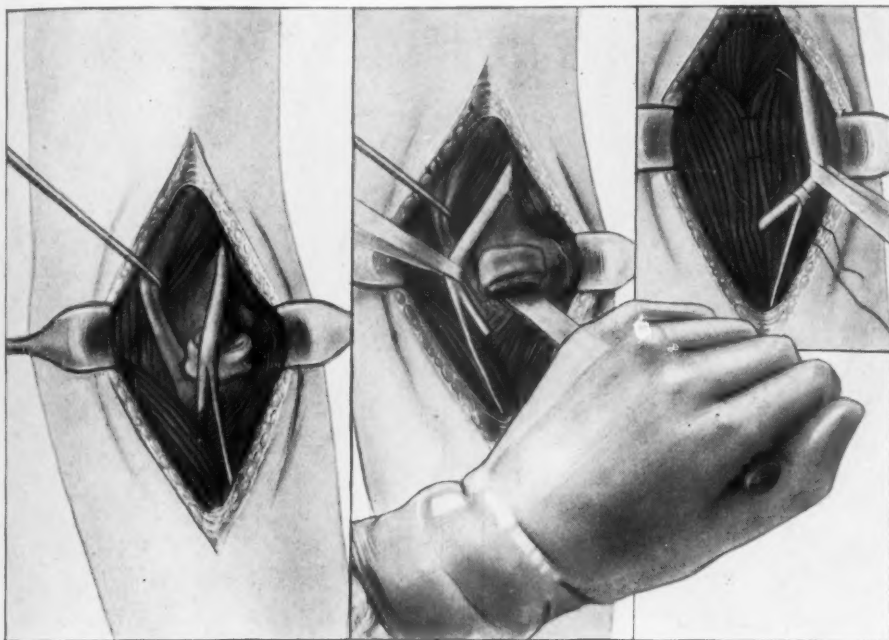


FIG. 3.—Operative findings in Case VII. The terminal portion of the radial and its two branches were pushed forward by the anterior dislocation of the head of radius. Patient recovered completely from the radial palsy.

ulation. Time between accident and operation—Four weeks. Operative findings—Nerve bound down by scar tissue and callus at lower end of radial groove. Good result. Period of total disability—Eighteen weeks.

CASE XI.—F. S., aged fifty-six. Etiology—Fall. Site of fracture—Junction of middle and lower thirds. Indications for operation—Radial palsy, overriding and comminution of fragments; allowed to heal in good functional alignment. Time between accident and operation—Five weeks. Operative findings—Nerve caught between two fragments of bone. Much scar tissue and callus. Good result. Period of total disability—Twenty-one weeks. (Fig. 4.)

CASE XII.—J. C., aged forty. Etiology—Auto. Site of fracture—Junction of middle and lower thirds. Indications for operation—Radial palsy, overriding and evidences of non-union. Time between accident and operation—Five weeks. Operative findings—Nerve found in much scar tissue and spicules of bone. Results—Not known.

CASE XIII.—J. G., aged fifty. Etiology—Auto. Site of fracture—Junction of middle

and lower thirds. Indications for operation—Radial palsy. Poor position of fragments, making an open reduction advisable. Time between accident and operation—Nine days. Operative findings—Nerve found red and swollen at the site of fracture. Good result. Period of total disability—Fourteen weeks.

CASE XIV.—M. M., aged fifty. Etiology—Auto. Site of fracture—Old anterior dislocation, radial head. Indications for operation—Radial palsy. Old anterior dislocation of head of radius. Time between accident and operation—Nine weeks. Oper-

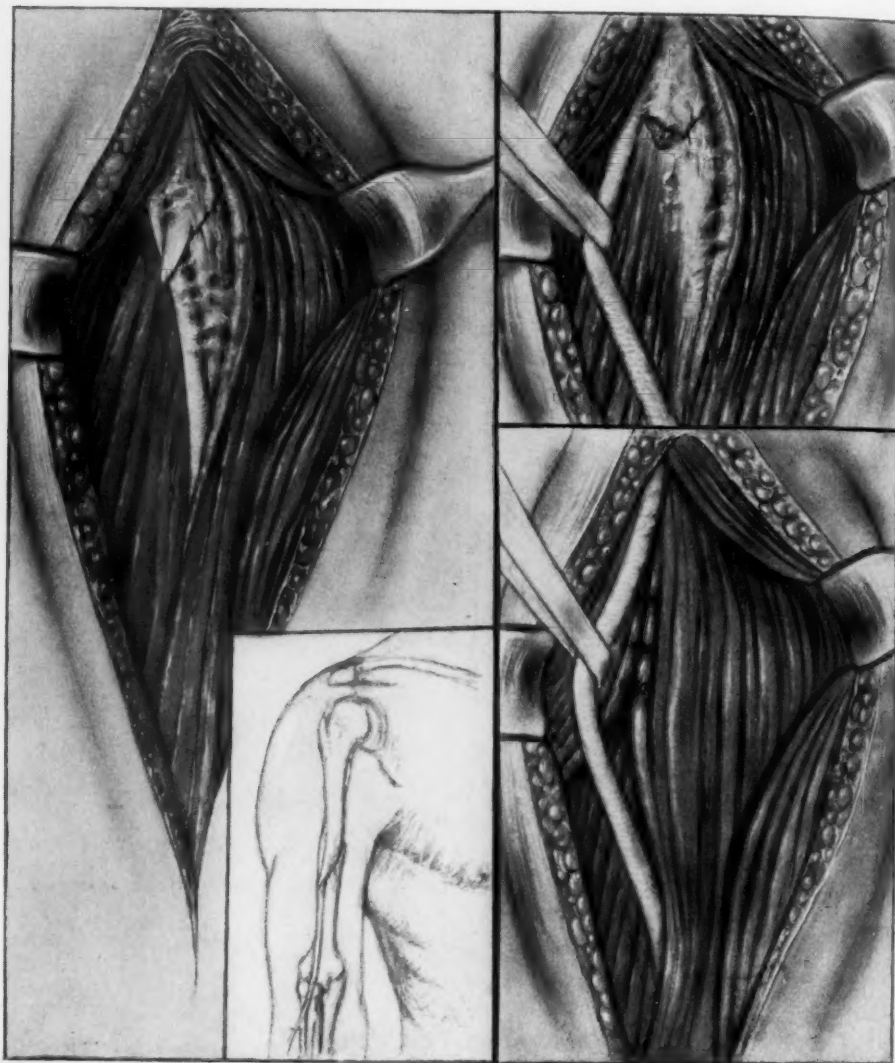


FIG. 4.—This is to show the operative findings in Case XI. The nerve was found caught between fragments of bone. Previous rays showed comminution and overriding at the site of trauma. Functional alignment was restored by traction and four weeks after the accident the nerve was explored. The operative findings in this case were such that conservatism could only aggravate the neural disability.

ative findings—Deep and superficial radial nerves bound down by scar and callus. Results—Not known.

The accompanying table summarizes the findings in the operated cases studied; it is evident that in seven a period of two and a half months and over

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had elapsed before operative intervention. In a certain number in this group operative treatment could have been advantageously used earlier. In the first case where the radial paralysis followed a bullet wound an exploratory could have been performed within about two or three weeks after injury. In Case II where instead of evidences of return of function there were signs indicative of increasing severity the patient could have been operated on much earlier. On the basis of pathological findings there was certainly no hope for amelioration. Case III also showed evidences of increasing severity and could have been treated earlier. In Case V there were evidences of non-union, and to have allowed such a case to go on any further may have meant eventual destruction of the nerve which was found in a bed of scar tissue and callus.

In the next seven cases operative intervention was effected before the end of three months. In Case VIII the disability was caused by a bullet wound and there was also evidence of median nerve disability. In Case IX there was a history of open reduction elsewhere for a supracondylar fracture. There was excessive callus formation about the elbow-joint and the probability of definite scar and callus inclusion was excellent. In the next case the radial palsy followed manipulation and it was not rash surgery to expose the nerve. In Case XI there was marked comminution of fragments and overriding. Good functional alignment was obtained by traction and the fracture was allowed to heal and four weeks later the nerve was exposed. There was no question that were this case allowed to carry on for three or four months irreparable damage would have ensued. In Case XII the indication for operation was non-union. In Case XIII poor position of fragments complicating primary radial paralysis made an open reduction preferable. In Case XIV the radial palsy was due to old anterior dislocation of the head of radius.

It is to be noted that the period of disability in the group where operation was performed before the three-month period is definitely shorter than in the preceding group where the three-month rule was followed. Among the later, disabilities of a year's duration are common; whereas in the group where early operation was used the upper limit of total period of disability is six months. Even though some cases may have recovered without intervention the operation in reality has done no damage. In the properly selected case I doubt if one would intervene where spontaneous recovery would obtain.

Because of the above considerations we believe in the following plan of attack in cases of fracture complicated by radial palsy. Given a primary paralysis due to a fracture in the upper third of the humerus above the level of the radial groove, conservative treatment for a period of from three to four months is definitely in order. In this position nerve and bone are widely separated by intervening muscular tissue. In such cases there would be paralysis of the triceps muscle and beginning recovery should certainly be noticed during this probationary period. On the other hand were it good surgery (in the opinion of the orthopaedist) to do an open reduction in such

a case, it is advisable to explore the nerve and transpose it into a live muscle bed. In fractures of the middle third complicated by radial palsy the presence of definite displacement of fragments with possible comminution is a good argument for scar and callus inclusion of nerve. In such cases as soon as sufficient callus has formed the nerve may be explored in the absence of returning function during this period. If there are no evidences of callus formation within a reasonable period of time an open reduction is indicated, for the middle third of the humerus shows non-union more frequently than any other portion of long bones. The presence of radial palsy in such a case should be a hastening factor for intervention. As a matter of fact, even in the absence of nerve palsy the radial should be dissected out and transposed into a live muscle bed when an operation is performed for non-union in the middle third of humerus. In fractures of the lower third with associated palsy, evidences of marked angulation, poor apposition, particularly in close vicinity to the elbow-joint, should favor an open operation which not only will insure good nerve function but will also enable the operator to get better functional alignment of bones. Here if the operation is done early it would be for the express purpose of reducing the fracture and at the same time transposing the nerve. If it is done four or five weeks after the accident it is in reality for purposes of transposing the nerve. We do not feel that early intervention is rash surgery particularly in fractures of the middle third and possibly also in fractures of the upper portion of the lower third associated with primary radial paralysis. As a rule we prefer waiting for a period of four to five weeks to obtain sufficient union of bones unless it is better surgery (according to the orthopædist) to intervene earlier for purposes of open reduction. In secondary paralysis it is advisable to study the patient for a few weeks for returning function. However, it must be confessed that most frequently neither patient nor consulting physician can state time of appearance of disability. Intervention later is justifiable. In the presence of radial palsy complicating old anterior dislocation of the head of the radius operative removal of the head of the radius seems justifiable.

In two cases conservative treatment was followed by return of function. In one there was fracture of the greater tuberosity of the humerus and anterior dislocation of the head. There was marked radial palsy and partial median. There were evidences of returning function after the third day. In another the fracture was in the lower third of the humerus with fragments in good apposition. There were evidences of returning function beginning the third week.

In the operative technic extreme asepsis is essential. We always prepare the field of operation two or three times before intervention. If the nerve is found of normal texture it is simply transposed into a live muscle bed. It is probably true that in the greatest majority no scar tissue contraction can occur with the nerve traversing a live muscle bed. If the nerve shows a small degree of enlargement (neuromatous degeneration) at the site of injury, it is advisable to perform a neurolysis to determine whether normal bundles

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traverse the area of pathology. If so, a simple neurolysis is sufficient. In two such cases, in this series, neurolysis was sufficient. On the other hand, if the enlargement is a true neuroma it may be necessary to resect it. We have had no occasion to suture the nerve in this series. If the nerve is actually severed, after shaving off the ends with a razor, an end-to-end suture may be effected. In the presence of marked loss of nerve tissue it may be necessary to dissect the nerve up and down in order to get more length. If this is not sufficient the nerve may be transposed anteriorly and in so doing one would have to dissect back the branches to the triceps. It is important to save these fibres, as emphasized by Pollock and Davis,⁵ for the disability brought about by triceps palsy is serious, possibly more so than the wrist-drop. The way cases of radial paralysis are treated at the present time it never should be necessary to resort to section of humerus. Lewis¹ advises against this procedure.

In cases of radial palsy complicating old anterior dislocation of the head of the radius we use the following operative approach: An incision about five inches long is made on the anterior aspect of the elbow along the medial border of the brachioradialis muscle. The nerve is located above the elbow between the brachioradialis and brachialis muscles. Then it is traced down along the anterior aspect of the elbow-joint and repaired according to pathological findings. The removal of the head of the radius is just as simple as by the usual lateral approach. However, the nerve has to be dissected out and retracted as shown in Fig. 3.

After the nerve is freed it is transposed into a live muscle bed. A few sutures approximating the deeper portions of the brachialis and brachioradialis muscles, posterior to the nerve, effect the desired result.

Depending upon level of injury the first evidences of return in function appear in the most proximal portion supplied by the nerve (as is well known). Thus in injuries of the middle third a beginning contraction of the supinator longus is evidence that the nerve is coming back. During the period of expectant therapy or after the operation of transposition the hand is supported by proper splints and with beginning evidences of contraction of the supinator longus muscle all splints are removed so as to enable the patient to use the limb as much as possible. During the period of disability physiotherapy, massage and electrical stimulation of the paralyzed muscles are, of course, in order.

Summary.—(1) This paper is based on fifteen cases of radial palsy complicating fractures and dislocations of the upper limb. The distribution of bony pathology is as follows: Fracture of the upper third of humerus, one case; fracture of middle third and junction of same with lower third, eight cases; supracondylar fracture, four cases; old anterior dislocation of the head of radius, two cases. One case of radial palsy due to scar tissue contraction about the nerve is also included as an example of typical secondary radial paralysis.

(2) Radial palsy complicating fracture of the humerus above the level of radial groove may be conservatively treated for three to four months. Radial palsy complicating fractures of the middle third of the humerus should be

explored within four to six weeks. Particularly is this true in the presence of comminution and overriding of fragments. Radial palsy complicating fractures of the humerus near the elbow-joint can advantageously be treated early, in selected cases. Not only will this insure good nerve function, but it will also enable the operator to get better functional alignment of bones. Radial palsy complicating old anterior dislocation of the head of the radius may be effectively treated by removal of the head of the radius through an anterior approach.

(3) In fractures of the humerus (particularly the middle third) manipulation of fragments should be done as little as possible. Functional alignment of bones by traction is more desirable to obviate nerve injury.

(4) Neurological examination in cases of fracture will always disclose primary nerve involvement. As a rule a few questions and answers are sufficient to diagnose the case.

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FRACTURE OF THE CAPITELLUM OF THE HUMERUS*

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OF PHILADELPHIA, PA.

THOUGH it would seem from the literature that the capitellum of the humerus is rarely fractured, for we have been able to find reports of but twenty-eight cases, there is the possibility that it is not so frequently diagnosed as it should be.

Fracture of the capitellum of the humerus was first reported in 1853 by Hahn,¹ of Germany, following an autopsy that he performed on a woman of sixty-three. He had treated her some years previously for fracture of the elbow and had obtained a very unsatisfactory result. Being curious to see the cause of the failure, he found at autopsy that a fragment of a fractured capitellum, which was dislocated upward and anteriorly, had locked the joint, causing ankylosis. (Fig. 1.)

We are reporting five cases which have come under our observation:

CASE I.—A white boy, seven years old, was brought to the accident ward of the Graduate Hospital of the University of Pennsylvania on June 14, 1930. His mother stated that on that day the child had fallen from a couch to the floor, a distance of about three feet, striking his elbow. There were swelling and pain in the region of the elbow, with almost complete fixation of the joint when he was first examined at the hospital. A diagnosis of fracture involving the bones of the elbow-joint was made and the extremity was placed in the Jones position. A few days later, the X-ray department reported "A fracture of the capitellum." (Fig. 2.)

The boy failed to return for treatment and the social service department found that he had moved to another city. About four and one-half months later we were finally successful in locating the child and he was readmitted for treatment. It was found at this time that the arm was practically fixed in the Jones position, and although the acute swelling had disappeared there remained a widening of the joint and marked limitation of the motions of pronation and supination. The limit of flexion was about 45° and of extension about 145°. An X-ray examination at this time was reported as follows: "Fracture of the capitellum humeri." (Fig. 3.) Operation was advised and the boy was admitted to the hospital October 21, 1930. The operation was performed November 4, 1930, by Dr. Walter Estell Lee and Dr. Thomas J. Summey. Under ether anaesthesia, a Kocher incision three inches in length was made over the external condyle. The joint

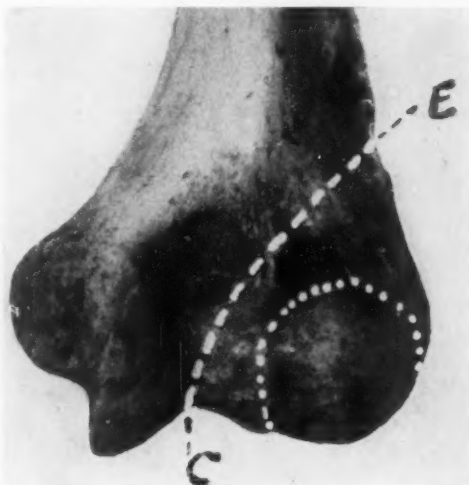


FIG. 1.—Normal humerus, showing the position of the external condyle and capitellum. (Ciacca.)

* Read before the Philadelphia Academy of Surgery, November 6, 1933.

cavity was entered and the fractured capitellum was found displaced upward and anteriorly and adherent to the capsule by a fibrous band. The capitellum was removed (Fig. 4), and the joint capsule was closed with chromic gut, the muscles with plain catgut, and skin with interrupted sutures of dermol. The arm was placed in full extension and held in this position by means of a molded plaster splint.

Recovery was uneventful and the patient was discharged November 14, 1930. He was re-admitted four times thereafter for manipulation of the joint under gas anesthesia. The first three times the arm was replaced in the molded plaster splint, and he was finally discharged December 30, 1930, with an excellent functional result, all movements of the elbow-joint and forearm being practically normal. January 1, 1932, a year later, the patient was seen by one of us (T.J.S.) and the function was found to be normal, there being no limitation of motion in any of the movements of the elbow-joint or forearm. (Fig. 5.)

CASE II.—White girl, eighteen years of age, came to the receiving ward of the Pennsylvania Hospital September 17, 1924, complaining of partial loss of function of the left elbow-joint. She stated that, some three months before, June 15, 1924, she fell down a flight of steps, landing on her left elbow. She applied for treatment at the dispensary of another hospital, where an X-ray examination was made and she was told that no fracture was present,

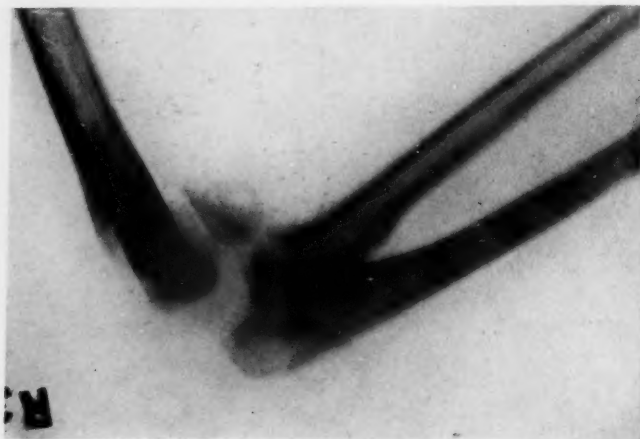


FIG. 2.—(Case I.) Lateral view.



FIG. 3.—(Case I.) Anteroposterior view.

and the arm was dressed upon an internal right-angle splint. For the following two weeks the arm was redressed at the same hospital, but upon removal of the splint at the end of two weeks she was unable to move the arm satisfactorily, and being dissatisfied, she consulted us.

At the time of our first examination we found the left elbow considerably thickened and the olecranon process not so prominent as on the opposite side, and there was marked tenderness in the antecubital fossa. Active and passive motions of extension and flexion of the left elbow were limited to about 50 per cent. of their normal range; pronation and supination were painful and very markedly limited, due to partial ankylosis. The report of an X-ray examination made at this time was "Fracture of the capitellum. The fragment is displaced forward so that the fractured surface of the distal fragment is practically at right angles to the articular surface of the radius. The condition is better seen in the lateral view, but it is very difficult, in fact, practically impossible to make it out in

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the anterior posterior view." Probably the lack of a lateral view at the time of the first X-ray examination explains the overlooking of this fracture.

Operation was advised and she was admitted to the hospital October 6, 1924, and operated upon October 11, 1924, under gas-ether anæsthesia. The operation was performed by Dr. Walter Estell Lee. An incision was made over the lateral aspect of the left elbow which was about three inches in length. Dissection was carried down through the scar tissue until the joint cavity was entered, where the capitellum was found dislocated forward and rotated medially and so placed that it locked the joint. The fragment was disengaged and removed without any difficulty, after which the joint capsule was closed with a continuous chromic catgut and the skin with a continuous silk suture. Four days after operation, the swelling and pain had disappeared and the incision was in excellent condition and passive motion was started. On the fourteenth day, the soft tissues having healed entirely, the adhesions were broken up by forcibly extending and flexing the elbow under gas anæsthesia, thereby securing full extension, flexion, pronation and supination. Two weeks later, November 13, 1924, under gas anæsthesia, the adhesions



FIG. 4.—(Case I.) Capitellum removed at operation.

were again loosened. The motions at this time were normal and the patient was discharged from the hospital November 15, 1924, and we have had no further report and have been unable to get in contact with the patient since that time.

CASE III.—White woman, aged seventy, April 14, 1931, while walking on a slippery pavement, fell, striking her elbow against the pavement. She complained of pain and noticed swelling which extended from below the shoulder down to the lower third of her forearm. The family physician, who saw her immediately after the accident, treated her conservatively, waiting until the swelling had sufficiently decreased for further treatment. After a week, the swelling and discoloration having disappeared, the patient was referred to one of us (T.J.S.) for treatment. On examination motions of the elbow-joint were found to be limited to about 60° of flexion and 140° of extension. Motions beyond these points were painful. Pronation and supination were also limited to about one-half of the normal. There was marked tenderness over the antecubital fossa, but no tenderness could be felt over any other bony point of the elbow-joint.

An X-ray examination at this time, April 20, 1931, made at the Burlington County Hospital, Mt. Holly, N. J., was reported as follows (Fig. 6): "Examination of left elbow shows a comminuted fracture of the capitellum of the humerus with the lateral half of the capitellum broken off and displaced anteriorly on the flexor surface of the

shaft of the humerus." Operation was advised, but refused, and we were able to use only baking and massage. No attempt at immobilization was made. After six weeks the patient had about 60 per cent. range of all movements of the elbow-joint and of the forearm, and she is now considering the advisability of having surgical intervention, but has not consented up to the time of this report. (Fig. 7.)

CASE IV.—White girl, eight years old, was brought to the receiving ward of the Pennsylvania Hospital June 24, 1928, with the history of having fallen a short time before while playing in the street and striking her right elbow on the pavement. The patient complained of a great deal of pain, held the joint in a fixed position and would not



FIG. 5.—(Case I.) Three years after operation, showing hypertrophy of the external condyle and a new capitulum.



FIG. 6.—(Case III.) Fracture of the capitellum not operated upon.

allow it to be moved. The clinical examination was very unsatisfactory because of lack of coöperation from the patient. X-ray examination revealed a fracture of the capitellum with anterior displacement of the fragment (Fig. 8). Operation was advised, the child's mother signed a release and the child left the hospital. We have been unable to trace this child since that time. (Fig. 9.)

CASE V.—Mrs. C., sixty-two years of age, was admitted to the Bryn Mawr Hospital December 16, 1933, following a fall in her home. It was very difficult to obtain an accurate history from her because of her lack of memory, but apparently she fell, striking the outer side of her left elbow. Dr. Sands who first saw her was at loss to explain the fact that while the landmarks of the elbow-joint seemed to be undisturbed, and though she had free flexion and extension, there was very definite crepitus. Upon admission to the

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hospital an X-ray picture showed not only a fracture of the external condyle but a fracture of the capitellum with the fragment dislocated inward, anteriorly and upward. (Fig. 10.) There was a good deal of ecchymosis and swelling about the elbow-joint so that operation was deferred until December 21, when through a Kocher incision, about three inches in length, made over the external condyle, the fragment was found lying outside the joint capsule and displaced anterior, medial and superior to its normal position. The fragment contained a part of the trochlear surface, but not enough to interfere with the stability of the humero-ulnar articulation. (Fig. 11.) There was a good deal of bruising of the muscles about the capsule of the joint with ecchymosis, but it was possible to expose the rent in the joint capsule and to approximate it and the muscles with a catgut suture and the skin and subcutaneous tissues with dermol sutures. Five weeks after the operation this patient had normal function.



FIG. 7.—(Case III.) Fracture of the capitellum unoperated. Lateral view.



FIG. 8.—(Case IV.) Fracture of the capitellum unoperated. Anteroposterior view.

ANATOMY.*—The lower extremity of the humerus is flattened from before backward, and terminates in a broad sloping articular surface which is subdivided by a low ridge into the trochlea and the capitellum.

The trochlea is the pulley-like surface which extends over the end of the humerus and articulates with the semilunar notch of the ulna. The trochlea is constricted in the centre and expanded laterally to form two prominent ridges, the medial one of which is thicker and descends lower, forming a marked projection; the lateral edge is narrower, corresponding in shape to the interval between the ulna and the radius. Above the trochlea are two fossæ; on the anterior surface is the coronoid fossa, an oval pit

* This description is taken almost verbatim from Gray's Anatomy.

which receives the coronoid process of the ulna when the forearm is flexed; while on the posterior surface is the olecranon fossa, a deep hollow for the reception of the anterior extremity of the olecranon process during extension of the forearm. These fossæ are usually separated by a thin translucent plate of bone, occasionally by fibrous tissue only, so that in a macerated specimen, a perforation, or supratrochlear foramen, might exist.

By comparison, the capitellum or the radial head of the humerus, on which the concave head of the radius plays, is much smaller and not far from being a portion of a sphere (being convex or nearly equally so in all directions, the arc from above downward being the longest). The capitellum is placed so much to the front of the humerus as to be nearly or quite invisible from behind, hence the articular surface is much more extensive on the front than on the back. The capitellum articulates perfectly with the concavity on the proximal end of the radius. Anteriorly on the humerus and immediately above the capitellum is a small depression, the radial fossa, which receives the anterior edge of the head of the radius in extreme flexion, whilst the medial margin of the head of the radius moves in a shallow groove between the capitellum and the trochlea. This last groove runs between the capitellum and the outer edge of the

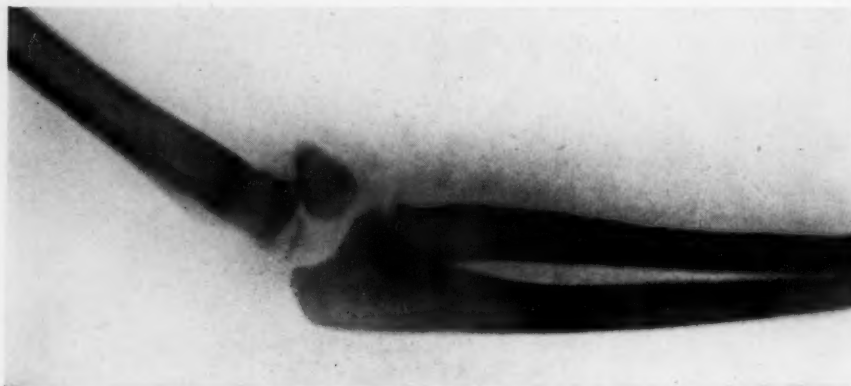


FIG. 9.—(Case IV.) Fracture of the capitellum unoperated. Lateral view.

trochlea; the outer border being straight, the posterior running obliquely backward and inward.

Thus it will be seen that the bones comprising the elbow-joint are the lower end of the humerus above and upper end of the radius and the ulna below; the articular surface of the humerus being partly received within the semilunar notch (great sigmoid cavity) of the ulna, and partly upon the cup-shaped area (fovea) of the radial head. It will also be noted that the elbow includes two articulations: the humero-ulnar, a pure hinge joint; and the humero-radial, a ball-and-socket joint. Besides these two articulations which enter into the mechanism of the hinge movement, there is always present within the capsule of the joint the proximal radio-ulnar articulation which is formed by the lateral surface of the radius articulating internally with the lesser sigmoid cavity of the ulna and is concerned in the movements of pronation and supination of the forearm.

The movements of the elbow are those of a true hinge joint, namely: flexion and extension. These movements are oblique so that the forearm is inclined medially in flexion, laterally in extension. The movements are limited by the contact, respectively, of the coronoid and olecranon processes of the ulna with their corresponding fossæ and the humerus; the extent of the movement is determined by the relative proportion between the length of the processes and the depth of the fossæ which receive them, rather than by the tension of the ligaments, or the bulk of the soft tissue parts over

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them. Thus the anterior and posterior portions of the capsule together with the posterior portion of the lateral ligaments are not put on the stretch during flexion and extension, and although they may assist in checking the velocity and prevent undue force and

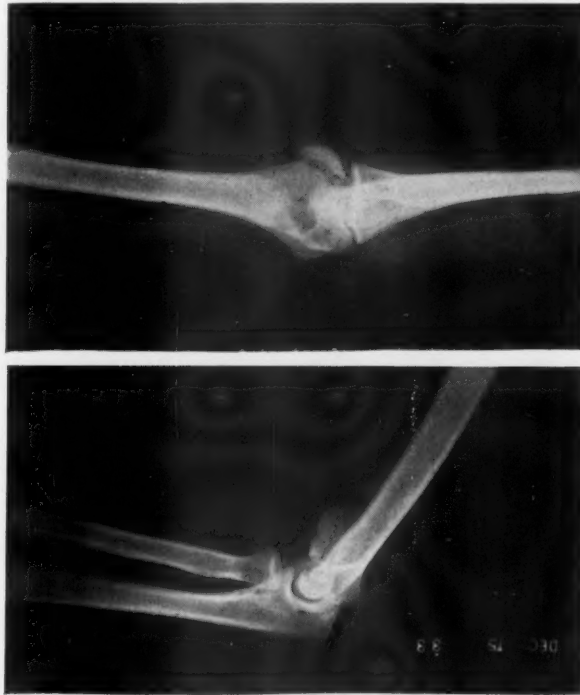


FIG. 10.—(Case V.) Mrs. C., Bryn Mawr Hospital, December, 1933, fracture of capitellum and internal condyle.

impact, they do not control or determine the extent of these movements. The limit of extension is reached when the ulna is nearly in a straight line with the humerus (180°); the limit of flexion when the ulna describes an angle of from 30° to 40° with the humerus.

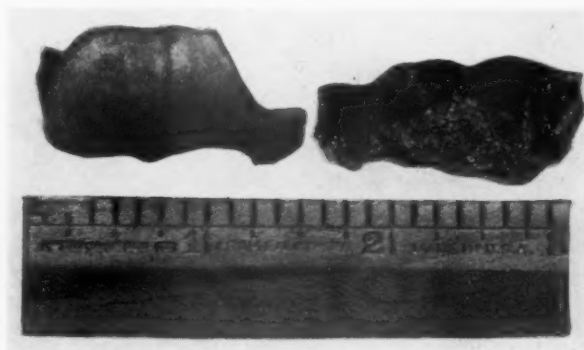


FIG. 11.—(Case V.) Photograph of fragment of bone removed. Articular surface on the left, fracture surface on the right.

PATHOLOGY.—Fracture of the capitellum of the humerus is essentially intra-articular since the epicondyle is not involved. Kocher³ and Lorenz⁵ pointed out that there are two distinct types of this fracture; the Hahn-Steinthal,² or complete fracture of the capitellum; and the Kocher-Lorenz, or partial or peeling fracture of the capitellum.

SYNOPSIS OF CASES FOUND RECORDED IN THE LITERATURE

Author	Age	Sex	Etiology of Injury	Crepitus	Position of Displaced Fragment	Degree Dysfunction Due to Injury	Degree of Pronation and Supination	X-ray Report	Treatment Operative or Other	Result and End-result
Hahn 1853	63	F	Drunken. Unknown.	Present	Upward and anterior displacement	No report	Normal	None	Autopsy	Poor--autopsy
Kocher 1896		M	Fell on extended left hand.	Present	Posterior to head of radius	Flexion to 55° Extension to 135°	Normal	None	Removal	Practically normal
	19	M	Carrying heavy weight with extended arm. In act of putting weight down, felt snap in elbow.	Present	Posterior displacement	Flexion normal Extension to 175°	Normal	None	Removal	Practically normal
	17	M	While riding horse, elbow was caught between high wall and side of horse.	Absent	Posterior displacement	Flexion normal Extension 135°	Normal	None	Removal	Practically normal
	14	M	Lifting wheelbarrow when snap was heard in elbow.	Absent	Posterior displacement	Flexion 50° Extension 145°	Normal	None	Removal	Practically normal
Steinthal 1898	20	M	Fell, striking right elbow in flexion.	Present	Anterior and upward displacement	Flexion 35° Extension 145°	No report	Positive	Removal	Flexion 90° Extension 160°
Stebbin 1879	24	F	Fell on extended hand.	Present	Posterior to head of radius	No report	No report	Positive with fracture of external condyle	No report	No report
Cotton	40	F	Fell six steps striking left elbow directly.	Present	No report	Flexion 90° Extension 130°	Much limited	Positive	Refused operation	No report
Lorenz 1905	20	M	With heavy hammer in act of striking.	Present	Posterior displacement	Flexion 135° Extension 150°	Normal	Positive	Removal	Normal. Complete restoration of function
	22	M	With iron rod in hand, striking an anvil.	Present	Posterior displacement	Flexion normal Extension 90°	Normal	Positive	Removal	Normal
Stimson	Adult	M	Falling stone struck elbow directly.	No report	No report	Suppurative joint ankylosis complete	No mention	No mention	Joint excised because of suppuration	No report
	Adult	M	Arm caught between tugboat and float.	No report	Posterior displacement	No report	No report	Positive	Fragment sutured back in place	Good
	12	M	Fell in street car with arm beneath him.	No report	Anterior displacement	90° to full extension	No report	Positive	Removal of portion of fragment	Good
Jopson 1913	38	M	Running across street, struck himself on left elbow.	Present on supination and pronation	Anterior and upward displacement, articulating surface points upward	No mention due to extreme pain	Limited much due to pain	Positive	Removal of detached fragment. Portion attached was left intact	Normal to extension 105°
Reinking 1909	9	M	Fell from wagon, striking left elbow.	No report	Posterior displacement	Flexion 45° Extension 140°	Pro-normal Sup-1/2	Positive	Replaced fragment	Normal to extension 170°

Wright	12	M	Fell on a left flexed elbow.	No report	No report	Arc of 40°	Normal	No report	Because of suppurative joint, joint was	No report
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Wright	12	M	Fell on a left flexed elbow.	No report	No report	Arc of 40°	Normal	No report	Because of suppurative joint, joint was excised.	No report
Patterson 1929	25	F	Fell on outstretched left hand.	No report	Anterior displacement	Elbow locked at 135°	No mention	Positive	Removal	Flexion 40° Extension 140°
Flint 1908	40	M	Fell 12 ft. on the elbow.	No report	Anterior displacement. Fragment upside down	Flexion 90° Extension 95°	No report	Positive	Removal	Flexion 45° Extension 170°
Del Bratto 1929	46	F	Fell from ladder. Position of arm not remembered.	Absent	Posterior and lateral displacement	Flexion 60° Extension 145°	No report	Positive	Arm placed at right angles for 30 days	Result poor
Ciacca 1928	51	F	Fell on left knee and elbow.	Present	Anterior and upward displacement	Extension to 150°	No report	Positive	Removal	Good
	17	M	Fell on left elbow.	No report	Anterior and upward displacement	Flexion 70° Extension 120°	No report	Positive	Removal	Good
	40	F	Fell downstairs, striking left elbow.	No report	Anterior and upward displacement	Extension to 150°	No report	Positive	Removal	Good
Von Saar 1912		M	Driving horse, with arm flexed acutely. Holding reins tightly, felt sudden severe pain in right elbow.	Present	No report	Unable to flex to right angle	No report	Positive	Removal	Good
		M	While lifting heavy rock, felt severe pain and heard crackle in elbow.	Present	No report	No report	No report	Positive	Removal	Good
Billet 1921	22	M	Soldier stumbled against step. Fell ventrally on abdomen and left elbow struck directly on ground. Did not fall on hand.	Present	No report	Unable to flex arm to right angle	No report	Positive	Removal	Normal function
	14	F	Girl, sweeping carpet, fell on left elbow, did not fall on hand.	No report	No report	Stiff elbow	No report	Trochlea also involved	Removal	Flexion normal Extension slight
Gay Bonnet 1924	20	M	Soldier fell from top of wagon on the left elbow.	Present	Anterior and upward displacement. Rough surface facing forward and up	Flexed to 90°	Pronation painful Supination limited	Positive	Removal 2 operations Capitellum in 2 fragments	Flexion 90° Extension 160°
	20	M	Soldier fell from wagon on right elbow.	No report	No report	Flexion 130° Extension 160°	Pronation good Supination incomplete	Positive	Removal	Normal
Lee and Summey 1930	7	M	Fell 3 ft. to floor on left elbow.	No report	Anterior and upward displacement	Flexion 45° Extension 145°	Limitation of both	Positive	Removal	Entirely normal in all movements
Lee 1924	18	F	Fell down steps on left elbow.	Absent	Anterior and downward displacement	50% of normal	Limitation	Positive	Removal	Entirely normal
Summey 1931	70	F	Fell in street on elbow.	No report	Anterior and upward displacement	Flexion 60° Extension 140°	50% normal	Positive	Operation refused because of age	50% normal
1928	8	F	Fell on elbow.	No report	Anterior displacement	50% normal	50% normal	Positive	Operation refused	Signed release Result unknown
1934	62	F	Fell on elbow.	Present	Anterior displacement	Normal	50% normal	Positive	Removal	Normal

The more common type, first described by Hahn and Steintal, is the complete or total fracture, where the fragment is formed of the capitellum together with a part, more or less extensive, of the external lip of the trochlea, is produced most often by a direct blow, such as a fall upon the elbow. When the elbow-joint is in the position of semi-flexion and semi-pronation, the lateral surface of the capitellum is fully exposed for such a direct blow. Twenty-two of the thirty-two cases reported were injured in this way. Another manner in which this dorsal fracture could be produced would be a fall upon the outstretched hand. In this type of fall the force is transmitted chiefly through the radius as the ulna does not articulate with the carpal bones. From the radius the force is transmitted to the external condyle of the humerus through the head of the radius which impinges upon the capitellum. While falls upon the hand frequently produce a transverse fracture above the condyle, sometimes a fracture of the external condyle alone, and also fractures of the head of the radius, they rarely produce a fracture of the internal condyle and very rarely a fracture of the capitellum. Only three of the thirty-two cases reviewed were produced in this way.

The second or Kocher-Lorenz type of fracture is much rarer and partakes of the nature of a partial or complete avulsion of the cartilage covering the capitellum, to which small portions of the bony substance may still be adherent to the fragment, and, this fragment being very small, may remain attached to the humerus by means of periosteal fibres. If free, it is usually displaced in the posterior position of the joint between the head of the radius, the olecranon process and the lateral condyle. These partial fractures are usually due to indirect violence and may be produced by the mechanisms of pulling, lifting or hammering. Kocher tries to point out that they are probably caused by traction through the anterior capsular attachments passing backward on the capsule and prying it off, as when the injury occurs while lifting with the forearm extended. Lorenz and Flint¹⁰ do not accept this explanation and Flint claims that this classification does not cover all the types of fractures of the capitellum, and that a further classification for such a small lesion is confusing rather than helpful. Six of the fractures in this series of thirty-three were of this nature.

Diagnosis.—The usual immediate clinical symptoms of a fracture, such as swelling, pain, localized tenderness of the part, dysfunction and crepitus, may all be present in fractures of the capitellum.

In this series of thirty-three cases we found recorded definite crepitus in fifteen cases, no crepitus in four, while in fourteen cases no mention was made of it. Crepitus, therefore, would not appear to be a constant clinical finding, probably due to the small size of the structure involved. Several points in differential diagnosis may here be considered. We know that whether it be a total or a partial fracture of the capitellum as differentiated by Kocher and Lorenz, it is always an intra-articular fracture of the elbow-joint, that is, it is always within the capsule joint. The fragment, therefore, acts as a foreign body within the joint. Thus the physical findings are those expected of a loose body within the joint. The degree of dysfunction of the elbow-joint in this series ranged all the way from complete ankylosis to all types of limited motion.

A fractured capitellum, it will be seen, is not a fracture of the external condyle of the humerus, therefore the external relations of the elbow are found to be normal, which constitutes a differential point in diagnosis.

As to displacement of the fragments, in eight of the cases no mention is made, ten had a posterior displacement, and fifteen had an anterior displace-

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ment of the fragments. In discussing the anatomy of the joint, we stated that the radial fossa on the front of the humerus received the anterior edge of the radius in the position of complete flexion of the forearm. Therefore, when the capitellum is completely separated and displaced anteriorly, it obstructs normal flexion by incarcerating itself between the radial fossa and the anterior edge of the head of the radius, and thus the most common disability is obstruction to the normal limits of flexion.

Should the capitellum be displaced posteriorly, extension would be limited, but to a lesser degree, for the displaced capitellum would be interposed between the posterior ligament of the capsule and the radial head, and, because of the pain following the stretching of the ligaments, the extension is limited by pain instead of bony fixation as in flexion.

Again, as the movements of the elbow-joint are those of a true hinge joint, the ulna articulating in perfect apposition with the trochlea of the humerus, the elbow-joint, unlike the knee-joint, depends for its security, strength and path of direction chiefly upon the configuration of its bones and especially the articulation between the ulna and the trochlea. This articulation may be singled out as a director of the elbow-joint. In flexion and extension, the cup-like depression of the radial head glides upon the capitellum and the medial margin of the radial head travels in the groove between the capitellum and the trochlea. This allows the radius to rotate upon the humerus while following the ulna in all its movements. In full extension, the head of the radius is barely in contact with the inferior surface of the capitellum and projects so far backward that its margin can be felt as a prominence at the back of the elbow. In full flexion, the anterior edge of the radial head is received into and checked against the depression above the capitellum, while in mid-flexion the cup-like depression is barely received upon the capitellum, and the radius being more completely steadied by the humerus in this position than in any other, pronation and supination take place most perfectly. Therefore, the articulation of the head of the radius with the capitellum is not necessary for the path of direction, in flexion or extension. If the radius were absent the hinge-like motion of the ulno-humeral joint would still be preserved. Thus the stability of the elbow-joint is not impaired in fractures of the capitellum.

Besides the hinge movements, it will be remembered there is also present within the capsule of the elbow-joint the proximal radial-ulna articulation allowing the mechanism of supination and pronation. It is readily seen that, although in injuries of the capitellum this articulation is rarely interfered with, the dislocation or interposition of the fragment of the capitellum usually does interfere with pronation and supination. In this series of thirty-two cases, in only eight were supination and pronation unaffected. In the rest of them the motion was limited by both pain and ankylosis in the old lesions.

TREATMENT.—Since it is true that the ulno-humeral joint is the main joint of the elbow and that, if the radius were absent, the hinge-like movement

would still be preserved, we can see that the danger of a fracture of the capitellum lies in its ability, as a foreign body, to act as a mechanical block limiting extension and flexion and also supination and pronation. In but two of the cases was an attempt made to replace the fragment of the capitellum, and one of them that was dressed in a right angle splint had a very poor result. Three who refused operation had poor results. Two other cases had the joint excised because of suppuration; and they must, of course, be counted as poor results. Of the twenty-two cases where surgical intervention was used and the fragment removed, all had good or entirely normal function following. Surgical removal of the fragment, therefore, seems to offer at present the most definite promise of a good functional result in fractures of the capitellum, unless the lesion is recognized very early and replaced immediately.

Summary.—Fracture of the capitellum, while apparently an unusual lesion, should be considered as a possibility in all injuries of the elbow-joint in which there is a history of direct violence upon the external condyle of the humerus, or of a force transmitted through the radius from the hand. Surgery is the only treatment that offers satisfactory functional results.

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COLLES' FRACTURE OF THE RADIUS

OBSERVATIONS ON 188 CASES

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FROM THE FOURTH SURGICAL DIVISION OF BELLEVUE HOSPITAL

FROM February, 1927, to September, 1932, 188 cases of Colles' fracture have been observed and treated on the Fourth Surgical Division of Bellevue Hospital. It has been the custom to follow this type of case in our divisional fracture clinic rather than in the regular out-patient department, so that when the case leaves the ward he remains under the observation of the surgeon originally attending him. In this way, the surgeon in charge of the fracture has the opportunity of caring for his patient from the time of admission to the hospital to the point of ultimate end-result. Of the total number of Colles' fractures which were admitted to our wards we were able to follow 128 cases, or 68 per cent. The remaining patients after returning home were either cared for by their private physicians or, if compensation cases, were taken over by the various insurance companies.

By the term Colles' fracture is meant a fracture of the lower end of the radius, within one and a half inches of the carpal joint surface, either with or without an accompanying fracture of the ulnar styloid. Impaction may or may not be present to a definite degree, though, if present, may result in a shortening of the radius with an accompanying undue prominence of the lower end of the ulna. The usual deformity is the characteristic silver-fork type, due to a posterior displacement of the lower fragment. The so-called reverse Colles' fracture is occasionally seen, in which the lower fragment of the radius is displaced anteriorly. This fracture is always caused by direct violence, usually from a fall on the outstretched hand.

Since the proper time to reduce any fracture is as soon as the patient is seen, as soon as the patient is admitted to the hospital, X-rays of the wrist, in both antero-posterior and lateral views, are taken and the interne on duty then notifies the visiting surgeon on call. The X-rays and the patient are then seen by the visiting surgeon and, if a reduction of the fracture is indicated, it is proceeded with at once. No case coming into the hospital in the evening is allowed to go unreduced until the following day.

Gas-oxygen is our anæsthetic of choice. Ether is practically never necessary, as the total time of anæsthesia required is always short. The use of 1 or 2 per cent. novocaine solution injected about the site of fracture as a local anæsthetic has been advocated quite enthusiastically by some observers. We have used it in twelve instances with very satisfactory results. There is, however, a potential danger in its use, due to the possibility of introducing infection into the site of fracture. Although this possibility is remote if adequate precautions are observed, the use of gas-oxygen is so eminently

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satisfactory that there is no reason for using any other form of anæsthesia when it is available.

As soon as the patient is anæsthetized, closed reduction of the fracture is accomplished. If any impaction is present it is completely broken up before reducing the lower fragment. When reduction is obtained we immobilize the wrist and forearm with the hand in a position of moderate palmar flexion and ulnar deviation. The forearm should be in a position of mid-supination. For immobilization we use anterior and posterior moulded splints, extending from the metacarpo-phalangeal joints to a point just below the elbow. It is important that the splints should not include the fingers, because of the likelihood of resulting stiffness therein. We insist upon active motion of the fingers, beginning as soon as the patient has recovered from the anæsthesia and continuing throughout the period of immobilization.

As soon as the effect of the anæsthesia has worn off, post-reduction X-rays are taken. If these show that a satisfactory reduction has been obtained, the patient is discharged from the hospital with instructions to return to the divisional fracture clinic the following week. All patients, however, are kept in the hospital for at least twenty-four hours following reduction so that any signs of constriction, due to a tight application of the moulded plaster splints, may be observed and corrected if present. If the original reduction is not satisfactory, a second attempt is made at once to improve the position. Fortunately this is seldom necessary, particularly if the first reduction is done shortly after the fracture has occurred and before swelling of the soft parts has taken place.

A certain number of cases do not require reduction. In these there exists only a simple crack through the bone, with no displacement of the lower fragment, no impaction and no tilting of the joint surface. Here simple immobilization is all that is required.

There is a group of cases, however, to which I wish to call attention. This group is composed of cases in which there is no posterior displacement of the lower fragment, but in which there is a greater or lesser degree of impaction, with a resulting shortening of the radius. I have frequently seen such a case treated by simple immobilization without any attempt at breaking up the impaction and trying to restore the normal length to the radius. We feel that this is a mistake. All of these cases should be anæsthetized, the impaction broken up and an attempt made to restore the normal length to the radius. If this is not done, it leaves the patient with a marked prominence of the lower end of the ulna and also with a prolonged period of disability due to recurring attacks of pain in the injured wrist.

Another group of cases in which reduction is frequently overlooked and in which it should always be attempted are those in which again there is no gross displacement of the lower fragment, but in which there is some posterior tilting of the joint surface of the radius. If this is allowed to go uncorrected, there will be a consequent loss of some degree of flexion at the wrist,

the amount lost depending upon the amount of tilting that has not been corrected.

We consider the treatment of epiphyseal separation of the lower end of the radius in children the same as Colles' fracture in the adult and as such it is included in this series. There are sixteen cases of epiphyseal separation included herein.

As for the period of immobilization, we believe in very early motion. Our average time of immobilization is from a week to ten days. At the end of this time the splints are removed and left off, the forearm is placed in a sling and active motion at the wrist, together with soaks in hot water twice a day and gentle massage once a day with olive oil, is begun. After a few days of this routine, the patient is referred to the department of occupational therapy, where suitably graduated exercises are prescribed and supervised. In this way very early persistent active motion in both wrist and fingers is obtained and if suitable reduction of the fracture has been obtained originally, it is not unusual for us to see our cases with complete range of motion at the wrist and in the fingers within four weeks.

We realize that we are somewhat radical in removing all immobilization within ten days. We do not claim that bony union has occurred in this space of time, but the fact is that sufficiently firm fibrous union has occurred, making it extremely difficult to move the lower fragment even at the end of one week. Anyone who has tried to reduce a Colles' fracture at the end of a week or ten days will be impressed by this fact.

I have seen a number of cases in which excellent reduction was obtained but the period of immobilization was continued for three or four weeks, which resulted in the patient's requiring three or four months to obtain anything like satisfactory motion at the wrist. I feel sure that in these cases the long period of disability was due to the wrist having been immobilized longer than was necessary. Occasionally one sees a case in which comminution of the lower fragment has occurred, and here we are inclined to increase the period of immobilization to two or two and a half weeks, but never longer. In any fracture which is near a joint, the sooner immobilization can be dispensed with and persistent active motion insisted upon, the quicker will adequate function be obtained. Muscular atrophy is slight in this space of time. I have seen cases in which splints have been left on for six to eight weeks and even with good reduction some of these cases never obtain satisfactory function.

I do not wish to appear too dogmatic relative to the above. It is always true that it is the exception that proves the rule, and that occasionally one will see a case in which the lower fragment, following a good reduction and immobilization for a week or ten days, will subsequently slip out of position. This, however, is so infrequent and the results from prolonged immobilization are so unfortunate that we cannot help the conclusion that the great majority of cases will be benefited immeasurably by shortening the usual period of immobilization. Summarizing the after-care, active motion, per-

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sistently carried out by the patient, is by far the most important. The use of hot-water soaks at home together with light massage with olive oil helps to more quickly limber up the part and relieve the stiffness. Occupational therapy has been found to be of maximum help, particularly in the patient who might be inclined to neglect active motion if left to himself.

It has been our experience that passive motion is of very little value and may do a great deal of harm by causing displacement at the site of fracture and by further traumatizing soft parts that have already been severely traumatized at the time of fracture. With active motion, however, these results cannot ensue, as the patient is constantly guided by the pain element. Then again the muscles profit by active motion.

Occupational therapy has been greatly neglected in most hospitals and its value in the after-treatment of fracture cases of all types cannot be too greatly stressed. We are impressed more and more of its usefulness in restoring function rapidly in fracture patients. Occupational therapy, such as block-printing, wood-working, and certain forms of metal-working, is simply a form of active motion in which the patient's attention is diverted from the injured part and directed towards some product that he is making, and by which, in so doing, he is persistently exercising his injured wrist. Patients are urged to report to the occupational therapy clinic at least three times a week. The work here is divided into hospital treatment and home exercises. All treatments are graduated from light to vigorous exercises and measurements as to progress are made each week. The home exercises are of value in preventing loss of motion during days between hospital visits.

By the simple routine of the procedures used in the occupations employed, excellent results have been obtained. The patients become so interested in the object that they are making that they tend to forget the pain and soreness in the injured wrist.

We have been able to follow 128 patients to the final end-result. Of this number the total period of disability (from the time of injury until the patient was able to return to his or her normal occupation) ranged from three weeks to fourteen weeks. The average period of disability was seven weeks. Of the epiphyseal separations in children, of which there were sixteen, we were able to follow thirteen cases. Here the average period of disability was four weeks. The disability ranged from two weeks to eight weeks. Very notable has been the rapidity with which these children regain a complete range of motion in a very short period of time. There has been no interference with subsequent growth of the radius in any of these cases.

There were seventy-two women and fifty-six men, and the ages according to decades were as follows:

10 to 20	30 patients
20 to 30	13 patients
30 to 40	13 patients
40 to 50	35 patients
50 to 60	25 patients
60 to 70	12 patients

There were no compensation cases in the above group. These always pass into the hands of the insurance companies as soon as the fracture has been reduced and the patient discharged from the hospital ward. I am quite sure that the average period of disability in a group of compensation cases would be considerably longer than it has been in non-compensation cases. It is human nature that it should be. Again we note that where there is a possible lawsuit in the future, in cases where the injury has been caused, for instance, by the patient being struck by an automobile, the patient will complain of pain and disability for a much longer period of time than the average.

In analyzing the end-results we have adopted the following method: (1) Cases in which the end-result is over 90 per cent. of normal from both the anatomical and functional standpoints are classed as EXCELLENT; (2) cases in which the end-result (anatomical and functional) is less than 90 per cent. but more than 75 per cent. are classed as SATISFACTORY; and (3) cases in which the end-result is less than 75 per cent. are classed as POOR.

It must be admitted that any method of classifying end-results in fractures is affected to some extent by the accuracy of those estimating the degree of anatomical and functional variation from the normal. We have endeavored to err on the side of the POOR rather than the GOOD. For instance, if a patient has normal function in all respects with complete range of motion in the wrist and fingers and normal grasping power and no pain, but presents some abnormal degree of ulnar prominence anatomically, we have classified such a case only as SATISFACTORY, even though from the standpoint of function there is a 100 per cent. result.

According to this classification, seventy-two cases or 56 per cent. may be classed as EXCELLENT, forty cases or 32 per cent. as SATISFACTORY and sixteen cases or 12 per cent. as POOR. In other words, 88 per cent. of the cases have obtained an end-result which is over 75 per cent. of normal, from both the anatomical and functional viewpoints. Of the POOR results, the commonest cause has been lack of coöperation on the part of the patient in carrying out the after-treatment. Some of our patients are of a very ignorant type and as long as any pain is present it is very difficult to get them to use active motion at all. We have been very much impressed by the long period of disability in such cases. Occasionally they never obtain good extension and flexion at the wrist. Unsatisfactory reduction has played a part in some of the POOR results, but not to a very marked degree. It has been surprising to note the excellent functional results that some of the cases with unsatisfactory reduction have obtained where occupational therapy was started early and conscientiously carried out.

PSEUDO-ARTHROSIS OF THE HIP FOLLOWING ACUTE INFECTION OF THE JOINT

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FROM THE DEPARTMENT OF ORTHOPEDICS OF THE UNIVERSITY OF MISSOURI

THE following case of pseudo-arthritis after infectious arthritis of the hip is reported for two reasons. The first is that it represents one of the unfortunate occurrences associated with the immunization against scarlet fever. The second is that a quite satisfactory result has been obtained in an



FIG. 1.—Bone shelf formed by head, with marked sclerosis of shelf and neck of femur. Definite pseudo-arthritis. Ossification of capsule inferiorly.

unusual manner after such a serious infection, using conservative methods of treatment.

Early in March, 1932, the patient, a fourteen-year-old boy, was given an inoculation against scarlet fever at his school. A few days later he complained of malaise and vague pain in the left hip. Two days after the onset of symptoms, the hip became much more painful, red and swollen and the patient was seriously ill with a high fever (104° – 105°). He was confined to bed at home for the following five months. During this entire time the leg was allowed to assume a position of complete extension at hip and knee

WILLIAM J. STEWART

(180 degrees) and extreme outward rotation with no other treatment. The hip became fixed in this position. Late in August, 1932, the patient started walking on crutches. He presented himself for examination at this clinic September 27, 1932.

Physical examination was essentially negative except for the extreme loss of weight and the condition of the left lower extremity. Wassermann and Kahn tests were negative. The hip was rigid and quite painful, in 180 degrees of extension, with the foot held in outward rotation of 80 degrees. Flexion of about five to ten degrees was present at the hip. Röntgen examination of the hip revealed the result of the infectious process, with mushrooming of the head, homogeneous density of the head, loss of cartilage space, no areas of absorption, and an open epiphyseal line. The rather broad neck was felt to be due to position—external rotation.

Because the head was well defined in the röntgenogram and because some slight motion at the hip was detected, it was felt that complete bony ankylosis of the head had not taken place. Accordingly, daily physical therapy and tank treatments were started.

Motion was gradually improved without exacerbation of the infectious process. Röntgenogram one month later revealed the truth of the condition. Flattening of the head in the acetabulum was demonstrated. The epiphyseal line was even more clearly shown. There was an area of absorption of the neck at the infero-mesial aspect, and there was increased density and bone sclerosis on the epiphyseal side of the line. Fluoroscopic examination confirmed the fact that the motion was originating in the epiphyseal line and that the condition was simply a slipped epiphysis that had not been permitted to unite.

Since motion was the desirable factor, manipulation, active and passive, was continued. Röntgenogram showed increased density of head and neck, pseudo-arthritis through the epiphyseal line and some beginning ossification of the capsule. At this time, flexion of twenty-five degrees, hyperextension of ten degrees and almost complete correction of external rotation had been obtained with very little pain on weight-bearing.

The last röntgen examination, December 22, 1932 (Fig. 1), showed still further bone sclerosis of the head, which projects from the ilium like a shelf, definite pseudo-arthritis, ossification of the capsule inferiorly and no areas of absorption in head or neck. Clinically, there is flexion forty degrees, hyperextension ten degrees, rotation thirty degrees, no adduction. Patient can sit almost completely erect in a straight chair, walks with a moderate limp, and has absolutely no pain even after walking a mile and a half. There is still some atrophy of thigh and calf. He wears a Thomas heel and uses a cane on slippery or ice-covered streets. His improvement has been most gratifying and there is every reason to believe that it will progress well beyond the present point.

TRANSACTIONS
OF THE
NEW YORK SURGICAL SOCIETY

STATED MEETING HELD APRIL 26, 1933

The President, DR. JOHN DOUGLAS, in the Chair

CONGENITAL CHONDRODYSPLASIA

DR. RUSSELL H. PATTERSON presented a man, aged twenty-one years, suffering from unsightly and annoying bony projections of various parts of the body. Those that bother him most are located on the left elbow, the right knee and right foot. The head of the left radius protrudes out under the skin, being dislocated some two inches. Bony prominences of varying



FIG. 1.—Hereditary deforming chondrodysplasia involving scaphoid and first metatarsal of the right foot.

sizes are felt on the right third finger; left clavicle; left humerus; left radius; left ulna; left fifth metacarpal; left fourth finger; right ilium; right femur; right tibia; right foot medially; left femur; left tibia; right radius. The right forearm measures three-quarters of an inch longer than the left forearm.

Films of the feet show an osteochondroma arising from the proximal half of the first metatarsal on the right. (Fig. 1.) The same process is seen

in the upper third of the left humerus. The cortex is expanded with formation of definite exostosis in the region of the greater tuberosity. The same process is seen in the upper third of the femora. There is some spur formation in the region of the lesser trochanter. There is also a spur formation in the ascending portions of the pubic bones. The same process is seen in the upper and lower thirds of the tibiae and fibulae, and in the lower third of the femora. (Fig. 3.) The spur formation in the lower medial portion of the lower third of the right femur is particularly marked. There is extremely marked deformity of both bones of the forearms. (Fig. 2.) There is a congenital dislocation of the left radius.

On January 18, 1929, the bony prominences causing the most symptoms were removed with sharp chisels so that these bones had somewhat their nor-



FIG. 2.—Hereditary deforming chondrodysplasia causing marked deformity of the bones of the forearm. Note the head of the left radius projecting under the skin.



FIG. 3.—Hereditary deforming chondrodysplasia involving condyles of femora, medial aspects of upper end of tibiae, and shaft of right fibula.

mal alignment. Such bony prominences removed were on the lower third of the right femur medially and the first tarso-metatarsal region of the right foot. Also two inches of the head of the left radius was removed. The cortex of these tumors had either a cartilaginous appearance or a bony appearance. The tumors were filled with cartilage or bony network about which was fat and mucinous-like material. They did not bleed very much. The wounds healed by primary union and convalescence was uneventful.

At the date of presentation, April 26, 1933, more than four years later, the patient is free of symptoms and has not noticed further growth of tumors.

This case is representative of so-called multiple congenital osteochondromata or hereditary deforming chondrodysplasia. It is usually described as congenital but such was not true in this case. The disease is always present very early in life, but is usually not noticed until early adult life. The

SARCOMA OF THE THYROID

increase in symptoms after the bony growths have remained stationary in size for a period of years is suggestive of malignancy. Malignancy occurs in the form of bone sarcoma but such cases are extremely rare. Jeck reported a case in June, 1929, in which there was malignant degeneration of one of these tumors of the pelvis with invasion of the bladder. There is a tendency to bilateral symmetrical involvement. There is a marked distortion of some of the bones during growth, particularly about the ulna and radius. Involvement of almost every bone in the body has been reported, though the skull is usually free. Bones are usually involved about the epiphyseal ends although at times the shaft is also involved. Honeij has reported changes in calcium metabolism. McCallum describes the pathology as follows:

Normal cartilage is not vascular and depends for its nutrition upon the absorption of fluid from the vessels of the perichondrium; no great bulk of it can maintain itself alive. But in cartilaginous tumors the tissue is in small districts and well supplied with nourishment from abundant blood-vessels which accompany its fibrous stroma. Blood-vessels sometimes grow into the cartilage as in normal endochondral ossification and convert it into bone, so that the chondroma eventually becomes a kind of osteoma. Usually a layer of cartilage remains over the surface. The calcification may occur in patches, or softening and cysts may form. The tumors may arise from congenital misplaced cartilage (Virchow) or from periosteum or endosteum forming cartilage and then bone.

DR. FRANK E. ADAIR said that a certain proportion of these cases become malignant and it is difficult to know when this will occur. They are accompanied by sudden growth and in trying to find out if they are malignant it is necessary to make a large section through the periphery toward the base.

SARCOMA OF THE THYROID

DOCTOR PATTERSON presented a man, forty-one years of age, who for eighteen years had had swelling in his neck, which caused no symptoms until the last three months during which time he has felt pressure in his throat, some change in his voice, and slight difficulty in swallowing. He was admitted to Bellevue Hospital March 27, 1933, with a very hard fixed tumor, apparently involving the whole of the thyroid gland, extending across the trachea, averaging some two and one-half inches in breadth. There are no regional palpable nodes. Laryngoscopical examination shows no involvement of the larynx though the trachea is definitely displaced to the right side. X-rays of the lungs showed a deviation of the trachea to the right. Extensive infiltration at the roots of both lungs. Dense fibrosis of the right lower lobe. Moderate interstitial changes and fibrosis in the lower lobe of the left lung. Lower portion of the right thorax is slightly collapsed.

Operation.—April 4, 1933, anaesthesia consisted of 75 milligrams of avertin per kilo or 3.8 cubic centimetres, the patient weighing 123 pounds. A small amount of 1 per cent. procaine was used as a local infiltration. Usual exposure of the thyroid gland made. A very firm tumor, brittle, very intimately attached to the trachea, extending out through capsule and involving the tape muscles on the left side of the neck. The isthmus was equally as large as the right and left lobes. Small chunks of tissue were enucleated.

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There was a grayish watery fluid that could be squeezed from these friable pieces of tumor tissue. Parts of the tumor were broken down into small caseous areas resembling tuberculosis. The trapezius muscles were infiltrated, the infiltration resembling that seen in broken-down lymphatic nodes of the neck. The condition at the time was thought to be of chronic inflammatory nature, perhaps tuberculosis. Four-fifths of the gland and tumor area was removed. There unquestionably was tumor tissue left. The wound was closed in the usual manner with a mid-line drain. The wound healed rapidly.

Temperature after operation went up as high as $103\frac{1}{2}^{\circ}$; pulse 125. Both were normal by the twelfth post-operative day. Reaction after operation was not marked. After the operation the patient was given three drops of Lugol's solution three times a day. On the seventh post-operative day X-ray radiation was begun but infiltration of the neck has progressed rapidly and unfavorably since the operation. The patient cannot swallow as well and his voice is more changed. Symptomatically he is fairly comfortable.

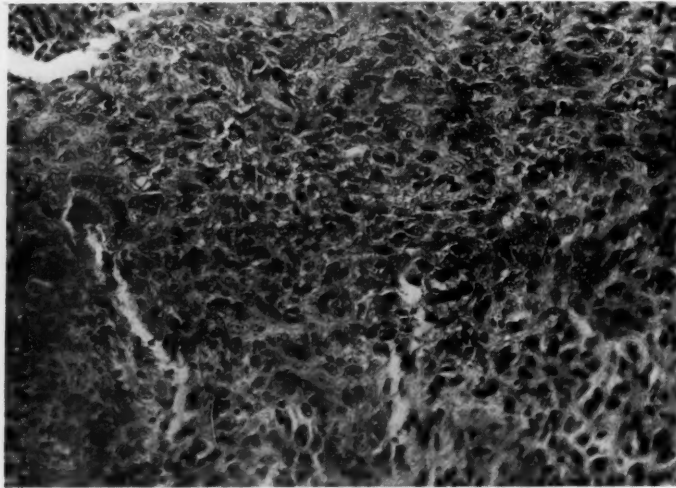


FIG. 4.—Sarcoma of thyroid. Medium power photomicrograph. Note spindle-cell arrangement, few giant-cells, numerous mitotic figures.

Culture taken from the substance of the tissue showed at the time of operation pure staphylococcus aureus. Histological sections (Fig. 4) have been diagnosed by Dr. Douglas Symmers of Bellevue Hospital as spindle-cell sarcoma. These sections show a very malignant tumor. There are quantities of mitotic figures. There are many scattered giant-cells which may be tumor cells or they may be reaction to the necrosis of the tumor, foreign body giant-cells. The type cell is a spindle cell. There is a matrix instead of a stroma indicating that the tumor is of the connective-tissue origin.

Proved cases of sarcoma of the thyroid gland are exceedingly rare, and the diagnosis in this case seems to be fairly certain. There are only two other cases (1917 and 1923) reported in the pathological files of Bellevue Hospital. There are forty-six cases of carcinoma recorded.

DR. ARTHUR S. McQUILLAN considered that this case illustrated very well several features which other observers have noted about these tumors. Their rarity is noteworthy and no doubt even more than present accounts

ANTERIOR DISLOCATION KNEE-JOINT

indicate if the theory is true that sarcomata have true origin in the thyroid gland are yet to be seen; these so-called thyroid sarcomata being invasions or metastases from extrinsic sources. Doctor Ewing and his co-workers at the General Memorial Hospital are inclined to believe that true thyroid sarcomata do not exist.

The single case of sarcoma in Doctor McQuillan's series, one of the three mentioned by Doctor Patterson at Bellevue Hospital, would seem in a way to bear out this theory, for in this case the tumor involved the right lateral neck structures as well as the thyroid gland. Doctor Rogers recently encountered an only case in his series. This was missed at the time of operation when the clinical and pathological diagnosis of the thyroid tumor was thyroid adenoma. It was only when the patient returned three months later with liver and inguinal lymph-node involvement that the original diagnosis was corrected, as reëxamination of the thyroid tumor revealed a small area of sarcoma. It is not impossible for this to have been an invasion or a metastasis since sarcomata usually invade through the blood-stream, so great is the vascular avenue of approach to the thyroid gland, so frequently does the blood filter through this gland.

However many observers believe in the true thyroid origin of sarcomata, there is still much confusion regarding the classification of these tumors. Pathologists talk about small round-cell carcinoma, giant-cell carcinoma and sarco-carcinoma. These terms are confusing and one is inclined to agree with Doctor Graham, of the Cleveland Clinic, who attaches more significance to the clinical course and behavior of these malignant tumors of the thyroid than to their microscopical structural appearance.

Doctor Patterson had emphasized the high basal metabolic rate, and symptoms of hyperthyroidism. These have been frequently noted by other observers as well as a rise in temperature.

As demonstrated by Doctor Patterson's case and others these sarcomata of the thyroid are engrafted upon a long-standing adenoma and occur in middle and late life. This is at variance with sarcomata occurring elsewhere. All agree that these tumors are fast-growing, invariably fatal and the cures by surgery are purely accidental.

ANTERIOR DISLOCATION KNEE-JOINT

DOCTOR PATTERSON presented a man, forty-six years of age, who was admitted to Bellevue Hospital March 13, 1933. On the day of admission he had fallen down ten steps in a subway station injuring his left knee. He was a large, healthy, strong man. His left knee was painful, swollen, and there was marked relaxation of the quadriceps. The bony condyles of the femur could be felt low in the popliteal space. The left foot was inverted. X-rays showed a marked dislocation at the left knee-joint. The condyles of the femur were in the popliteal space behind the head of the tibia. (Fig. 5.)

Under gas-oxygen anæsthesia the left thigh was flexed to a right angle. A sheet was placed around it and tied to the head of the bed. Traction was then applied to the left foot, pulling the tibia forward and downward (in

flexion) off the anterior surface of the condyles of the left femur. The left lower extremity was put in a Thomas splint with slight skin traction. Eight hours later a circular plaster-of-Paris bandage was applied from the left groin down including the left foot, the knee being flexed some fifteen degrees. At the end of three weeks the plaster-of-Paris bandage was removed. The left knee was found to be one and one-half inches larger than the right knee. There was a complete toe-drop. Patient was fitted with a Thomas ambulatory splint and physical therapy was begun. Four months after the accident the patient could flex the knee to a right angle. Complete extension was possible but the toe-drop had not improved. There was no abnormal lateral mobility



FIG. 5.—Complete anterior dislocation of left knee-joint. Lateral view.

present in the left knee. A neurological note of November 6, 1930, one and one-half years after the accident, was as follows:

This patient had a mild residual left foot drop and sensory hyperesthesia. Improving in the last one and one-half years. Believe it was a case of pressure neuritis of the left perineal with the result of palsy. Do not think nerve was severed. No atrophy and extent of sensory change is against this.

About the same condition of the foot exists today. There is normal flexion of the knee-joint, no abnormal lateral motion, extension normal, excellent function—no brace.

This condition is a very uncommon accident, being the only one the speaker knew of on the Cornell division at Bellevue Hospital during his thir-

EPITHELIOMA OF LEG

teen years' service. The condition has always attracted the attention of the medical profession. Astley Cooper in 1832 described two cases of dislocation of the knee—one was in the year 1802 and the other in 1806. The dislocations are divided according to the direction in which the tibia is displaced. The anterior dislocations constitute about half of those recorded. The injury most often occurs by hyperextension of the knee. Stimson speaks of three cases where both knees were dislocated. Several of the old books speak of amputations necessitated by injury to the popliteal vessels.

In this case the crucial ligaments must have been completely divided and the posterior ligaments of the knee-joint were probably detached along with the periosteum—somewhat as if one had performed a posterior capsulotomy—yet the stability in the knee is remarkable.

DR. JOHN J. MOORHEAD said that complete dislocations of the anterior form are rare with no resultant damage to the crucial ligaments. Apparently the effects of crucial ligament injury has been overstressed in respect to knee-joint trauma. In most of the cases definite evidence of crucial injury is lacking. The secret of success in the management of this case was the promptness with which reduction was accomplished.

EPITHELIOMA OF LEG

DR. JOHN H. GARLOCK presented a man, fifty-eight years of age, who was admitted to the second surgical division of the New York Hospital September 29, 1931, with the following history:

Two and a half years before, he accidentally bumped the left shin against an object. The leg became swollen and discolored. The injury finally healed, after the application of numerous home remedies, leaving a noticeable thickening of the skin over the front of the upper leg. About one month later, a warty excrescence appeared in the centre of the thickened skin. This the patient removed himself with a knife. Bleeding was profuse following this operation. The resulting wound failed to heal and grew slowly larger and larger during the following two and a half years. For four or five weeks before admission to the hospital, the tumor mass had grown quite rapidly. (Fig. 1.)

Examination showed a large, irregular, oval, cauliflower, fungating surface tumor situated just below the left knee on the anterior aspect of the leg. It measured seven by ten centimetres. The surrounding skin was thin, shiny, and discolored. The lesion itself was tender to touch and was covered with foul-smelling discharge. It was freely mobile on the deeper structures, except over the region of the tibial tubercle, to which it seemed firmly attached. Three small nodes were felt in the left groin. The rest of the examination was negative. The liver was not enlarged, and the chest was clear. X-rays of the various long bones were negative, except for the left tibia, which showed an irregularity at the level of the tibial tubercle. The Kline test was four plus. A biopsy taken from the edge of the lesion, on October 1, disclosed a squamous-celled carcinoma. October 3 the lymph-nodes were removed from the left groin, which, upon pathological examination, failed to disclose metastases.

The surface of the tumor was cleansed with daily dressings of Dakin solution. October 15 the entire mass was excised with the electric cutting knife. The lesion was outlined by an incision three-quarters of an inch away from

its edge. It was found to be intimately adherent to the tibial tubercle. The latter structure was removed with the growth in one piece. The resulting defect was treated subsequently by the Carrel-Dakin method and was covered by a pedicled flap swing from the opposite thigh. (Fig. 2.) The graft took without incident, and all wounds healed rapidly. (Fig. 3.) The patient was discharged January 27, 1932. He has been well ever since. There is no evidence of a recurrence. The skin over the front of the knee is soft and pliable, and motion in the knee-joint is normal.

This patient is presented because of the enormous size of the epithelioma and its attachment to the tibia. The speaker called attention to the value of pedicled flaps in covering defects over parts of the body exposed to con-



FIG. 1.—Appearance of lesion upon admission to hospital.

stant trauma, and needing a covering of greater thickness and durability than can be offered by the use of Thiersch or split-thickness grafts.

DR. GEORGE H. SEMKEN stated that Doctor Garlock's case could be discussed from two standpoints—one, that of the carcinoma; the other, that of the reparative procedure.

It is not probable that the trauma directly caused the carcinoma; but this patient probably had an unnoticed epithelial papilloma at that site, which was stimulated to a more active growth by the trauma and became the prominent wart. This, in turn, became more intensively activated in growth by the knife-cut made by the patient; and somewhere in this course, the carcinomatous addition occurred.

EPITHELIOMA OF LEG

The regional lymph-nodes, in this instance, were removed as the first step in the procedure, and the primary cancer was excised at a later date. From the cancer viewpoint this order should have been reversed. Since it is understood that cancer cells from the primary tumor find their way via the lymphatic vessels into the lymph-nodes, the primary removal of the lymph-nodes alone leaves a cavity with a raw surface into which the lymphatic vessels discharge lymph that may contain cancer cells. Cancer implantation is thus produced on an ideal surface for a cancer graft. It is safer, therefore, to defer the removal of the regional lymph-nodes until after the excision of the primary



FIG. 2.

FIG. 2.—Method of "waltzing" flap from anterior aspect of right thigh to point of attachment on the inner side of left thigh, preparatory to covering of defect in front of knee.



FIG. 3.

FIG. 3.—Photograph of end-result two years after operation. Scar marking the donor site of the tubed flap which covered the defect is indicated.

cancer, so that it is the last step of one operation or is done at a later date. The removal of the lymph-nodes at a later date has the advantage of giving the lymphatic vessels (at least theoretically), time to discharge the contained cancer cells, if any, into the lymph-nodes; and tends thus to increase the certainty of the cancer removal.

Doctor Garlock's method of repairing the large defect on the leg with a tubular skin flap transplant from the other thigh has been ingenious and successful, but it has necessitated a long period of treatment. It is simpler, in these cases, to do the cancer excision and the reparative procedure at one operation. As the first step, the ulcerated cancer surface is lightly cauterized to prevent viable cancer cells from being rubbed off and reimplanted in the

wound during the excision. The cancer is then removed by the usual method of surgical excision rather than with the endotherm knife; and the resultant defect is covered with a sliding flap taken from the adjacent region. In cases like the present one, this flap could be taken from the inner surface of the leg, with the pedicle at the knee. If the area of excision is too wide to be covered by the available flap, the flap is laid across the area of greatest motion or stress, and the remaining raw surfaces above or below the flap are covered with an immediate Thiersch graft. The defect at the site from which the flap was taken is narrowed with sutures about the margin, and the remaining raw surface is covered with a primary Thiersch graft also. The after-care is simple and the period of hospitalization is short.

RECONSTRUCTION OF LOWER LIP, CHIN AND NECK FOR BURN CONTRACTURE

DOCTOR GARLOCK presented a girl of fourteen, who was admitted to the second surgical division of the New York Hospital July 28, 1931.

At the age of eight she sustained severe burns due to hot water, involving the neck, chest, and left axilla. The burns healed, and produced a severe contracture, involving especially the neck and lower lip. Six months later, an attempt was made to correct this contracture, but the result was unsatisfactory. The patient, although fourteen years of age, has the mentality of of six- or seven-year-old child. Because of this, the procedures that were contemplated had to take into consideration the fact that there would be no cooperation on the part of the patient.

Examination showed a cicatricial contraction of the neck, more marked on the left side, resulting in a marked ectropion of the lower lip with constant drooling of saliva. (Fig. 4.) The skin on the back was scarred superficially in various regions.

July 30, 1931, a flap of skin measuring ten by three inches, was outlined on the back, extending from the mid-line opposite the first thoracic vertebra downwards and to the left. This was fashioned into a tube. The remaining skin edges on the chest wall were undermined and approximated beneath the flap. These wounds healed by primary union, and the patient was discharged from the hospital.

The second stage was performed October 24, 1931. (Fig. 5.) An area measuring five by three and one-half inches, was marked out on the chest wall, extending from the distal extremity of the original tubed flap but remaining attached to it. This flap was lifted from the underlying muscle and was immediately replaced and sutured in its original bed. The purpose of this procedure was to permit an adequate blood supply through the tubed flap before complete separation from the chest wall.

The next operation was done November 4, 1931. The rectangular flap was again lifted from the chest wall, and was extended distally for another inch and a half. The incision was then rounded for an inch and a half on each side, thus beginning the cutting through of the last attachment to the chest wall. The flap was separated off from the underlying chest wall all around except for the attachment of an area about two and a half inches in length. After control of bleeding, the flap was replaced in its bed and sutured.

November 16, 1931, the fourth stage was performed. The previously outlined rectangular flap was dissected free from the underlying structures on all sides, and separated free from the chest wall. Its nutrition was excellent,

RECONSTRUCTION FOR BURN CONTRACTURE

and actively bleeding vessels were found down to its distal end. The remaining raw area on the chest wall was covered with Thiersch grafts taken from both thighs. The patient was then turned about. The contracting scar on the left side of the neck was excised from the anterior border of the trapezius muscle to the mid-line of the neck and from the ramus of the mandible down to the clavicle. This defect corresponded to the size of the skin flap at the end of the tubed flap. The flap was then laid into the defect and sutured into place. Dead space was obliterated by placing interrupted sutures of plain catgut between the under surface of the flap and the neck wound. A zero-form ointment dressing and pressure bandage were applied. The part was immobilized in a plaster case which included the head, neck, and thorax with



FIG. 4.—Appearance of patient before operative correction.



FIG. 5.—Photograph of patient after second operation. Tubed flap has been raised. The second operation consisted of the raising of a quadrilateral flap as indicated in the photograph.

both arms by the side. In order to prevent any form of pressure on the tubed flap, a specially devised cradle was placed over it underneath the plaster cast. The flap healed by primary union and the cast was removed on the twelfth post-operative day. The patient was discharged from the hospital.

She was readmitted April 7, 1932. On April 25, the fifth stage was done. (Fig. 6.) In order to correct a contracture which was taking place in the mid-line of the neck, a "Z" plastic was done at this site. This immediately eliminated the vertical scar in the middle of the neck and permitted complete extension of the head. At the same time the posterior extremity of the original tubed flap was cut across transversely. The tube was opened along its original suture line posteriorly for half the length of the tube. This formed a flat piece of skin and subcutaneous tissues measuring about one

and three-quarter inches transversely, and two and a half inches longitudinally. The blood supply was excellent. The scar along the left side of the lower lip and chin was then excised so as to correct the ectropion of the lip. The opened-up part of the tubed flap was then laid into this defect and sutured into place. Zeroform ointment pressure dressing was then applied. The head, deviated slight to the left, and neck, were then immobilized in a plaster case.

Another stage in the plastic repair was done May 18, 1932. At this time the remaining pedicle of the original tubular flap, which was situated on the lateral aspect of the neck, was divided transversely, and the defect in the neck at this point was closed with horsehair stitches. This part of the tubed flap was then opened up along its original suture line for a distance of about an inch. Excess subcutaneous fat was removed. The scar just below the ver-



FIG. 6.—Appearance of the patient following the fifth operation. Posterior extremity of the original tubed flap has been divided, and this end of the tube inserted into a defect in the chin following excision of more scar.

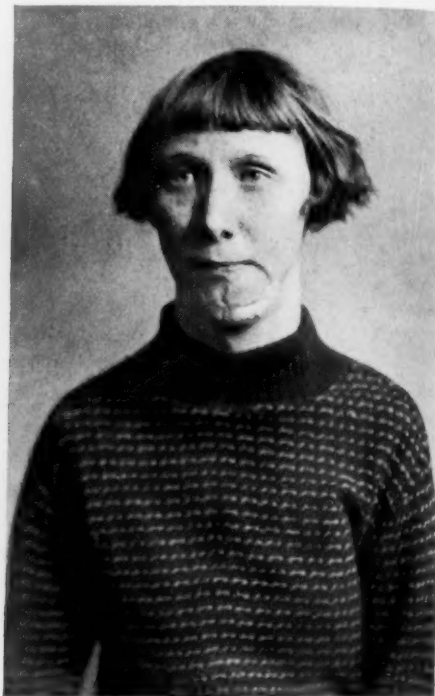


FIG. 7. (Case II.)—Photograph of patient about six months after final operation.

million border of the lower lip was then excised, leaving a defect measuring one inch long and one and a half inches wide. The edges of the defect were undermined and the remainder of the flap turned upon itself and inserted into this defect. The size of the flap at this point was somewhat larger than the defect which it covered in order to compensate for expected future contraction. Primary union took place. June 4, 1932, the final operation was performed and consisted in excision of the remainder of the tubed flap and readjusting of the remaining wound edges so as to produce an even contour of the chin and adjacent lower lip.

These various procedures have resulted in a well-shaped chin, a straight mouth, and a normal neck outline. (Fig. 7.) The skin is soft and pliable, and resembles closely the texture of the skin of the face and neck.

RECONSTRUCTION FOR BURN CONTRACTURE

DOCTOR GARLOCK presented a second case in the person of a woman, aged thirty-six years, who was first admitted to the second surgical division of the New York Hospital December 13, 1931. Thirty years before, at the age of six, she had been severely burned at an open-grate fire. The burns involved the face, chin, neck and hands. Healing finally took place with deforming scars, resulting in a marked ectropion of the lower lip, scarring of the neck and chin, producing loss of the normal contour of these structures, ectropion of the right upper eyelid which prevented closure of the lids, and an opacity of the right cornea.

When admitted to the hospital there was an absence of the outer three-quarters of the right eyebrow. The right upper eyelid was scarred and contracted to such a degree as to prevent closure of the eyelids. There was a



FIG. 8.



FIG. 9.

FIG. 8.—Appearance of patient before operative correction. There is a dense scar extending from the vermillion border of the lower lip to the manubrium, and involving the chin and neck and lateral aspects of the face. There is a complete ectropion of the lower lip. The ectropion in the right lower lid and the loss of most of the right upper eyebrow is indicated.

FIG. 9.—Final result after numerous operations described in the text. The transplanted skin is soft and pliable, and the contour of the neck and chin has been restored. The change in the appearance of the right upper eyelid following transplantation of a split-thickness skin graft is evident.

small opacity of the cornea. There were thickened pitted scars involving the chin and neck. The lower lip was everted to such an extent as to bring to view the lower teeth and gum. The vermillion border was attached to the border of the chin. There was an absence of the normal contour of the neck and chin due to extensive scarring which also prevented extension of the head. (Fig. 8.)

December 16, 1931, the first stage was performed by the formation of a tube from the skin of the back. The remaining skin edges were undermined and approximated beneath the flap.

April 17, 1932, the second stage was performed, consisting of the outlining of a flap, four by six inches, continuous with the distal extremity of the tubular flap. This was lifted from the chest wall except at its distal at-

tachment. It was then immediately replaced and sutured in its bed. On May 2, 1932, the flap was again raised as at the previous operation, but was extended for another inch and curved around at its distal extremity until it remained attached to the chest wall by one inch of skin and subcutaneous tissue. It was then resutured into its original bed. The object of these two operations was to permit of the formation of an adequate blood supply through the original tubed flap.

May 23, 1932, the fourth-stage operation was performed. The quadrilateral flap which had been lifted on the two previous occasions, and which was continuous with the distal extremity of the original tubed flap, was completely lifted from the chest wall after incision through the original suture line. A considerable amount of subcutaneous fat was removed from its under surface. Viability to this flap seemed excellent, and numerous actively bleeding vessels were found as far as its distal extremity. The defect on the chest wall thus produced was closed by a plastic undermining so as to produce an H-shaped scar. The field of operation was then changed and the patient placed upon her back. The entire scar over the front of the chin below the lip and including a large part of the neck was completely excised. This permitted the lower lip to resume its normal position. All the subcutaneous fat was removed from this area. The defect measured four by six inches. The original tubed flap was swung around the neck, and the quadrilateral flap inserted into the chin and neck defect. Precautions were taken to obliterate dead space, and the skin edges approximated with horsehair stitches. Because of the laxity of the tubed flap, and the excellent coöperation of the patient, no retentive apparatus was necessary. Healing took place by primary union without necrosis of any part of the flap.

June 30, 1932, the proximal attachment of the original tubed flap in the region of the left shoulder was divided. The tube was opened along its original suture line for a third of its distance, and converted into a flat section of skin and subcutaneous tissues. An area of scar tissue was excised from the right side of the chin and adjacent neck. The tubed flap was then turned upon itself and its opened-up distal end was accurately fitted into the newly created defect on the right side of the chin. Healing took place by primary union.

July 19, 1932, the original distal attachment of the tubed graft to the quadrilateral flap was cut across on the left side of the neck. The remaining wound was repaired. This end of the tube was then opened up along its original suture line so as to form a flat piece of skin measuring three by two and a half inches. This was used to replace a scar at the base of the neck which was excised. It was sutured into this newly created defect, and healed by primary union.

August 18, 1932, that part of the tubed flap which was attached to the right side of the chin June 30, was divided. The excess fat was removed and the wound was repaired. The remainder of the tube was then used to fill a defect following excision of a scar marking the distal extremity of the original rectangular flap. All these wounds healed by primary union.

In the following few months, it was noted that a vertical ridge of scar tissue was forming near the centre of the neck preventing full extension of the head and producing a slight ectropion of the right side of the lower lip. To correct this deformity, a "Z" plastic was performed January 8, 1933, with extensive undermining of the two flaps of the "Z." The flaps were transposed and sutured into place with fine horsehair. Primary union resulted. There was no sloughing of the tips of the flaps. The ridged scar was thus completely obliterated.

RECONSTRUCTION FOR BURN CONTRACTURE

February 15, 1933, the entire scar of the right upper eyelid was excised, extending from almost the lid margin to the region of the eyebrow. Scar tissue strands were found extending into the substance of the orbicularis muscle. A split-thickness graft was then taken from the inner side of the left arm and placed over a mold of dental compound. This was sutured in such a way as to evert the upper eyelid. The first dressing was done on the eighth post-operative day, and it was found that the graft had taken completely.

The final operation was performed on March 23, 1933, at which time a full-thickness skin graft taken from the temple region of the scalp was inserted into a defect created in the right eyebrow region in order to replace the lost eyebrow. This graft took without incident.

These various procedures have resulted in a normal contour of the chin



FIG. 10.—Close-up photograph of upper eyelid showing the return of skin wrinkling. The growth of hair in the new eyebrow has not reached its full extent.

and neck, and a reposition of the lower lip to its normal state. (Fig. 9.) The various scars on the chin and neck have been so placed that, should they contract, no deformity will result. The new skin is soft and pliable and approaches the texture and appearance of the skin of the rest of the face. The right upper eyelid is soft and pliable, and of sufficient length to permit closure of the lids. The new eyebrow is growing hair which, in the future, will require trimming. (Fig. 10.)

These two cases were presented to illustrate a method for covering the chin and neck with normal skin for the correction of cicatricial contractures following burns. Of course, numerous operations are necessary, but success is assured with the exercise of care in obtaining adequate blood supply of the various flaps. The full-thickness skin graft can be used to cover such defects, but because of the uneven contour of the area involved and the necessary motion of the cricoid cartilage during the act of deglutition a successful "take" becomes highly problematic. A split-thickness graft can also be used

in this situation, as recently advocated by Blair. However, the 40 to 50 per cent. contraction which takes place in these grafts subsequently, and the change in appearance of the grafted skin, are serious objections to its use in this situation.

ACTINOMYCOSIS OF TRANSVERSE MESOCOLON AND GREAT OMENTUM

DOCTOR GARLOCK presented a woman, fifty-seven years of age, who was first seen November 15, 1928, at which time she presented a severe exophthalmic goitre of four years' duration. The basal metabolic rate was +83 per cent. After preliminary preparation with Lugol's solution, rest in bed, *etc.*, a subtotal thyroidectomy was performed December 13, 1928. Following this, she gained thirty pounds in weight and was clinically well. She was seen again October 2, 1929, at which time she complained of indigestion and distress in the lower abdomen, of five weeks' duration. She belched considerably and had lost six pounds in weight. A large mass was detectable in the lower abdomen below the umbilicus, approximately in the mid-line. It was slightly tender, firm, and somewhat movable. The tumor seemed to be connected with the uterus. October 10, 1929, a lower right rectus incision was made.



FIG. 11.—Gross and microscopic pictures of excised specimen. The major portion of the pathology was located in the great omentum immediately attached to the transverse colon. Microscopic section shows the characteristic ray fungus.

The tumor was about six inches in diameter and situated in the great omentum immediately attached to the transverse colon. (Fig. 11.) It was reddish-blue in color, and presented a necrotic area on its anterior surface. The parietal peritoneum was markedly thickened for about two inches on each side of the incision. There were no palpably enlarged lymph-nodes and the liver was negative. It was difficult to tell whether the mass arose from the bowel wall or from without the bowel. Under the supposition that the tumor was a carcinoma, the transverse colon was resected. The ends of the divided bowel were inverted and a side-to-side three-layer anastomosis performed. The thickened parietal peritoneum was excised as far as possible and the wound closed after placing two cigarette drains at the lower angle. Pathological report of the excised specimen states that it consisted of transverse colon, seventeen centimetres in length with attached mesocolon and omentum. Colon is normal. The pathology is located in the mesentery. There is a diffuse inflammatory process extending irregularly through the fat in all directions, forming variable sized pockets filled with broken-down tissue. Some of this resembles pus, some necrotic fat. In some, hæmorrhage has occurred. No mesenteric thrombosis could be found. The general appearance is not suggestive of tumor. No communication with the gut is demon-

CARCINOMA OF TONSIL

strable. The microscopical examination disclosed the presence of colonies of organisms resembling actinomycosis. Following operation, the blood sugar rose to .210 per cent. This was controlled with insulin and diet, so that after ten days, the blood sugar was .159 per cent. She left the hospital November 1, 1929, with the wound completely healed.

She was readmitted to the hospital November 21, 1929, with the history that pain had developed in the epigastrium and that she had noted a firm mass in this area. Examination revealed the presence of a mass in the right upper quadrant. It was somewhat tender and firm, and felt fixed.

November 22, 1929, the tumor was exposed by an upper right rectus incision. The mass was two inches above the upper limits of the former incision. The parietal peritoneum was somewhat thickened and densely adherent to the large bowel. In the upper half of the incision, the peritoneum was freed and the abdomen was found filled with adhesions. Along the course of the falciform ligament near the surface of the liver was situated the mass. Gentle manipulation revealed an abscess containing two ounces of thick, yellow, odorless pus. A biopsy was taken from the walls of the abscess cavity and cultures of the pus were made. Two cigarette drains were inserted and the wound was closed loosely in layers. Pathological examination of the biopsy specimen failed to disclose actinomycosis. There was a dense polynuclear leucocytic infiltration. The cultures showed no growth.

Post-operatively, the wound was irrigated with 25 per cent. potassium iodide solution daily, 10 cubic centimetres being left in the wound. During the patient's stay in the hospital, she received fourteen injections of sodium iodide intravenously, fifteen grains at each dose. She was also given large doses of potassium iodide by mouth. Following discharge from the hospital, twelve more injections of sodium iodide were given. A tube was kept in the sinus until the first part of August, 1930. Following its removal, the sinus closed almost overnight. In addition, six deep X-ray treatments were administered following her discharge from the hospital.

At the present time she is perfectly well, her bowels move regularly, she is doing her regular work, and has gained thirty pounds in weight. Examination shows both incisions to be firmly healed. There is no palpable mass or thickening anywhere in the abdomen.

This case is presented as one of actinomycosis of the transverse mesocolon and great omentum, having its origin from the transverse colon. The secondary abscess probably was secondary to leakage from the suture line after the intestinal resection. The administration of large doses of iodides, both by vein and by mouth, and the course of deep X-ray therapy were probably important factors in the recovery of this patient.

CARCINOMA OF TONSIL

DR. CARL EGGERS presented a man, fifty-eight years of age, who was admitted to the Lenox Hill Hospital, June 6, 1929, on account of a swelling in his throat which he had noticed ten days before. There had been discomfort but no pain and no difficulty in swallowing.

He had complained of dyspnoea on exertion for ten years, precordial pain with radiation into the left arm for three years, and swelling of the feet for several days. He weighed 129 pounds, and he did not look sick. General examination showed moderate hypertension with a blood-pressure of 160/90, slight enlargement of the heart to the left, with a systolic murmur at the apex and base. The urine showed a trace of albumen with casts, but the blood chemistry was within normal limits. The Wassermann examination was negative. X-ray examination of the chest was negative.

Locally he presented a hard, nodular tumor about the size of a plum in the right tonsillar fossa. It was apparently strictly limited to the tonsil. It bled easily, and impressed as a malignant growth. There was no gross evidence of metastatic cervical lymph-node involvement.

Under rectal oil-ether anæsthesia the mouth was opened wide with a gag, and with a suture through the tip of the tongue for traction and with long retractors, the tonsil region was well exposed. A silk suture was placed at the commissure above the tonsil for traction, and with a flat electrocautery the entire tumor together with both pillars of the fauces was excised down to the base of the tongue, and the dissection was then continued downward until there was assurance of being well below the lesion, and the entire specimen removed in one piece. The floor of the pharyngeal wound was then again lightly cauterized. There was very little bleeding which was controlled with the cautery and with a few well-placed deep suture ligatures. The convalescence was uneventful. The highest temperature was 101.6° at the end of the second day. He was discharged, cured, on the fourteenth day. There has been no sign of trouble since. The pathological report was: Squamous-cell epithelioma of the tonsil.

RETICULUM-CELL SARCOMA OF THE TONSIL AND CERVICAL LYMPH-NODES

DOCTOR EGGERS presented a man, forty-three years of age, who was admitted to the Lenox Hill Hospital, January 30, 1928. A week before a swelling had been noted on his left upper neck, with enlargement of the left tonsil. The tonsil was removed by Dr. John D. Kernan, who did a clean dissection and encountered no unusual difficulty. Pathological examination showed early reticulum-cell sarcoma of the left tonsil and chronic inflammation of the opposite one. Two days after the tonsillectomy he was seen by the reporter. His general condition was good. The tonsillar fossæ were lined with a thick exudate and the tongue was coated. Below the angle of the left jaw, corresponding to the region of the superficial cervical lymph-nodes, there was a deep-seated mass about the size of a walnut, somewhat movable and not tender to touch. There were no skin changes and no fluctuation could be made out. The surrounding lymph-nodes did not seem involved. There was no general lymph-node enlargement. Chest examination was negative, and a röntgen picture showed no involvement of the lungs. Examination of the blood showed no abnormality.

In view of the positive diagnosis of sarcoma of the tonsil a diagnosis of secondary lymph-node involvement was made. Operation was deferred for a week to allow the tonsil fossæ to heal and thereby diminish the possibility of pulmonary infection by aspiration.

Under general inhalation anæsthesia an incision was made along the anterior border of the left sternocleidomastoid muscle from the ear lobule almost down to the clavicle. A transverse incision was added at the level of the hyoid bone, extending forward to the median line. The skin flaps so outlined were dissected back together with the platysma. A radical block dissection of the neck was then done including the submaxillary, the superficial, and the deep cervical regions. The submaxillary salivary gland and the lower pole of the parotid gland were removed together with the tumor and the cervical lymph-nodes. A stab wound was made behind the sternocleidomastoid muscle for the exit of two split-tube drains, and the entire wound then closed. The platysma was sutured with continuous plain catgut and the skin with interrupted silk. Primary union resulted, and the patient was discharged eleven days after operation. While still in the hospital X-ray treatments were

BILATERAL SUBPHRENIC ABSCESS

begun, to include the cervical and thoracic regions, and they were continued after discharge.

Pathological examination showed no involvement of the submaxillary or parotid salivary glands. The tumor itself and several of the surrounding lymph-nodes showed reticulum-cell sarcoma. The entire chain of deep posterior cervical lymph-nodes was not involved.

About five months later the patient again noticed a swelling on the left side of the neck. It impressed as an enlarged lymph-node, was about the size of a hazelnut and situated next to the larynx. It was movable and not tender. There was no evidence of recurrence in the mouth or scar. The node was removed under local anæsthesia together with surrounding fat and connective tissue. It was reported as a hyperplastic lymph-node.

There has been no trouble since.

This case was presented because of the comparative rarity of the tumor and its high degree of malignancy. New and Broders of the Mayo Clinic have made a careful study of tumors of the nasopharynx, pharynx and base of the tongue. The most common are lymphosarcoma and transitional cell carcinoma, with the latter about seven times more common than the former. Eighty-four per cent. of all lesions occurred in males. Many of the patients noted enlargement of the cervical lymph-nodes as the first sign of the disease.

These sarcomata of the pharynx are very malignant and are highly radio-sensitive. For this reason some surgeons advise radiotherapy as the method of choice. In operable cases it is advisable to do a radical excision of the primary lesion followed by a block dissection of the neck and subsequent X-ray treatment as was done in this case.

BILATERAL SUBPHRENIC ABSCESS SECONDARY TO PERFORATED GASTRIC ULCER

DR. EGGERS presented a man, forty-two years of age, who was admitted to the medical service of the Lenox Hill Hospital, January 10, 1933, with the following history: Ten days before he was suddenly seized with very severe general abdominal cramps followed by stabbing pain in the epigastrium. Since that time he has had persistent intense soreness in that region. Pain has radiated to both shoulders, and at times through to the back. There has been some nausea but no vomiting and the appetite has been poor. He has not been jaundiced. There have been no respiratory or cardiac symptoms.

At onset of attack he was unable to void and had to be catheterized, but there has been no difficulty since. He has had fever and has lost considerable weight. Hiccough developed on the day of admission and has been very annoying.

In the past history the only item of interest was belching of gas for several months, most marked about two hours after his midday meal, and relieved by sodium bicarbonate.

He had a temperature of 103.2° , pulse 112, respiration 28. There were signs in the chest suspicious of a pneumonic infiltration about the angle of the scapula on the left side. The other definite findings were tenderness in the epigastrium and an apparently enlarged liver, the margin of which could be felt three fingers below the costal arch. Blood examination showed the following: Red blood cells, 4,950,000, hæmoglobin, 90 per cent.; white blood cells, 20,900; polymorphonuclears, 77 per cent.; leucocytes, 23 per cent. The urine showed 2+ albumen, and an occasional granular cast. There was no sugar or other abnormal ingredients. A blood chemistry examination done the following day was within normal limits.

Bedside röntgen films were made with the patient sitting up. The chest was negative. A fluid level was visible in the upper abdomen, about two inches below the dome of the diaphragm and extending almost from one side of the abdomen to the other. Above this fluid level a small collection of air was visible. The lower border of the right lobe of the liver was seen on a level with the crest of the ilium. (Figs. 1 and 2.)

At the time of the surgical consultation January 11, 1933, the patient looked very sick. His eyes were sunken, and the tongue heavily coated. There was a temperature of 103.8° , with a pulse rate of 108. The lungs were clear. The abdomen was flat and nothing abnormal could be made out over the lower portions. In the epigastrium, extending about halfway down from the ensiform to the umbilicus and equally to both sides, there was marked fullness with tenderness and rigidity. A diagnosis of subphrenic abscess was made, most likely due to a perforated gastric ulcer.

Immediate operation was performed under general anæsthesia. A median



FIG. 1.—Bilateral subphrenic abscess eleven days after perforation of a gastric ulcer.



FIG. 2.—Collection of air under both diaphragms eighteen hours after perforation of a pyloric ulcer.

epigastric incision was made and a large abscess cavity entered. After evacuating about 1,000 cubic centimetres of creamy yellow pus by suction the cavity could be inspected. It was situated just beneath the diaphragm, the floor was formed by the liver which had become adherent to the anterior abdominal wall. Toward the right the cavity was walled off, apparently by the falciform ligament, while toward the left a finger could be passed around the edge of the liver into a deep-seated cavity toward the stomach. The origin of the pus could not be definitely determined but was assumed to be secondary to a perforated ulcer.

Culture of the pus showed pneumococcus type III, while the smear showed Gram-negative bacilli, Gram-positive bacilli, and Gram-positive diplococci. The patient ran a rather stormy course for about two weeks, with temperature ranging from 100° to 103.8° . During this period he had a bilateral bronchopneumonia, verified by röntgen examination. On typing his sputum there was no agglutination with types I, II, or III.

As soon as he had recovered sufficiently a study was made of his gastro-

DILATATION OF COMMON DUCT AFTER CHOLECYSTECTOMY

intestinal tract. The test meal showed free acid to be normal, while the total acid was rather high. There was no blood present. Röntgen examination showed constant deformity of the prepyloric region with an ulcer niche on the lesser curvature. There was no six-hour retention. The patient was transferred to the medical service for prolonged ulcer treatment and was discharged from the hospital two months after admission. He has been kept under observation but he has no abnormal symptoms at present.

He was presented because of the long time which elapsed between the perforation and admission to the hospital, and because of the aid in diagnosis furnished by the flat X-ray examination of the upper abdomen. The presence of air under the diaphragm is taken as an indication of the perforation of a hollow viscus. Owing to the long time which elapsed in this case an inflammatory exudate developed secondarily to the accumulated fluid resulting from the perforation. The presence of pneumococci is probably due to secondary invasion. He apparently had pneumococci in his system because he had signs suggestive of pneumonia at the time of admission and he developed bilateral bronchopneumonia due to pneumococci after operation.

Soon after admission of this case another patient came to the service of the reporter with the diagnosis of perforated ulcer. In him also the X-ray was of considerable help in substantiating the diagnosis. Air was shown under both diaphragms, but, owing to the recent perforation, no fluid had formed. It is not common to see such a large collection; usually there is but a small amount which becomes visible just beneath the diaphragm. It is important to select the proper position for X-ray, for when lying flat the air may not show, while in the sitting position the liver drops down slightly and allows air to become visible between it and the diaphragm.

DILATATION OF COMMON DUCT WITH PAIN AND JAUNDICE THREE AND ONE-HALF YEARS AFTER CHOLECYSTECTOMY

DOCTOR EGGERS presented a man, forty-seven years of age, who was admitted to the Lenox Hill Hospital, May 30, 1928, on account of attacks of pain in the right upper abdomen, which had occurred over a period of three months. He had signs of acute cholecystitis with a temperature of 102.2° , and a pulse of 102. The white blood cells were 9,800, with 82 per cent. polymorphonuclears. There was no jaundice and the icteric index was 10. The Wassermann test was negative. There was no contraindication to operation, and a few days after the temperature reached normal a cholecystectomy was done under general anæsthesia. Palpation of the common duct did not reveal any stones or other abnormality. The abdomen was drained with a cigarette drain and there was some bile drainage for a while. The pathological examination showed acute hæmorrhagic and chronic cholecystitis and cholelithiasis. Culture of the bile was negative. The convalescence was uneventful and the patient was discharged, cured, four weeks after operation.

He was re-admitted nine months later, March 15, 1929, complaining of burning pain in the stomach, which had suddenly started two weeks before. It had gradually become more intense, had remained localized in the mid-epigastrium and was associated with occasional vomiting, loss of appetite, and marked constipation. He had severe pain when first examined and he was quite jaundiced. The abdomen was soft and the liver not enlarged. There was tenderness in the epigastrium and along the right costal arch without rigidity. A diagnosis of probable calculus in the common duct was made.

During a period of observation, lasting three weeks, he had several attacks of pain and vomiting and the temperature varied from normal to 101° . Blood chemistry was within normal limits, and a blood count showed 12,400

white blood cells with 84 per cent. polymorphonuclears. The coagulation time of the blood was considerably increased and the Van den Bergh test was reported direct, positive, immediate. On admission the icterus index was 55, it then came down for a while but went up to 71 later, and from that time on gradually fell to normal. Coincident with this there was symptomatic relief and the patient was discharged with the most likely diagnosis of common duct calculus, which had passed.

December 3, 1931, almost three years later, he was admitted for the third time, on account of acute epigastric pain which had begun suddenly a few hours before. He stated that since his last previous discharge he had had a number of comparatively mild attacks of pain, seldom lasting over an hour. Except for these attacks he had considered himself in good health. He was quite jaundiced; his icterus index was reported to be 27. The abdomen was soft; there was separation of the fascia in the old scar, but without any hernial protrusion. The liver edge could not be felt, and no abnormal mass could be made out.

Laboratory examinations did not help in establishing a definite diagnosis. Wassermann was again negative. Röntgen-ray examination did not show any stone nor a dilated common duct. There was a slight fever, the highest point being 101.4° . A diagnosis of obstructive jaundice was made, probably due to pressure on the duct from without, by means of old adhesions producing angulation, or due to a stone within the duct. With recurrent attacks an operation seemed indicated.

The old scar was excised. It was found that the fascia had completely separated and that the omentum was adherent to the scar as well as to the margins of the fascia defect and internal organs. There were also additional extensive intra-abdominal adhesions involving two loops of small intestines and the liver. After much difficulty the bile-duct system was exposed. The common duct was enormously dilated to the size of the duodenum, but its wall was not particularly thickened. After mobilizing the duodenum palpation of the common duct and pancreas was possible. There was no stone within the duct, but the pancreas was hard and nodular for its entire length. The nodules were visible through the peritoneum, and in parts the latter was adherent to them. Several small areas of fat necrosis were seen, but there were none at a distance from the pancreas.

No cause for the dilatation of the common duct could be found except the extensive adhesions, or the pancreatitis. In order to determine the patency of the duct a choledochotomy was done. A considerable quantity of thin, fairly clear bile was aspirated. (It was later reported sterile.) The duct was so large it could easily be explored with the index finger; there was no stone present and no tumor could be felt. Downward the finger apparently passed through a dilated papilla into the duodenum. Subsequently a bougie was passed down through the duct into the duodenum. With an open papilla there seemed to be no reason for drainage of the duct. The opening was therefore closed with interrupted chromic catgut sutures. Two cigarette drains were inserted and the abdominal wall was then repaired.

The explanation of the symptoms and findings in the patient were difficult. The three definite findings were extensive adhesions, a dilated common duct and papilla, and chronic pancreatitis which had apparently been acute at some time. The dilated duct was apparently not due to mechanical obstruction, at least none was found at operation. It may be explained on the theory of spontaneous dilatation, having assumed the function of the gall-bladder, but the dilated papilla could hardly be explained on this theory. There may be disturbance of the nerve control of the duct secondary to acute pancreatitis

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with possible involvement of sympathetic ganglia. The patient probably never had a common duct stone although there is a possibility that the dilated papilla was due to the passage of a large stone into the duodenum. The two attacks of severe abdominal pain may have been due to acute pancreatitis and the associated jaundice due to temporary obstruction or to regurgitation of bile or duodenal contents through the dilated papilla into the common duct.

The prognosis seemed doubtful. If the papilla remains dilated one may reasonably expect repeated regurgitation into the common duct with possible ascending infection and secondary damage to the liver and pancreas. To test out this possibility a duodenal tube was passed about three weeks after operation. When the end of the tube was in the region of the ampulla, lipiodol, and later a thin bismuth emulsion, were forcibly injected and observed under the fluoroscope. It was impossible to outline the biliary ducts; the opaque mixture passed rapidly downward into the small intestines. It appeared from this observation that rather high pressure is required before duodenal contents can enter the common duct. In order to create such high pressure it seemed necessary to temporarily obstruct the duodenum at a place somewhat below the papilla and thereby simulate conditions such as may be brought about by spastic contracture of the duodenum.

A special duodenal tube was therefore constructed by Dr. Alvin G. Dujat for this purpose. It consists of two pieces of 0.4-centimetre duodenal tubing of conventional length joined together at four-inch intervals with silk ligature material. Both tubes are fitted with a closing valve at the oral end; and one, which is four inches longer than the other, is equipped at its duodenal end with a small inflatable rubber balloon arrangement which is, of course, inflated from its oral end with air after it has passed through the pylorus into the duodenum. Inside the rubber balloon is a metal "duodenal bucket" which aids in visualizing progress of the end of the tube through the stomach and duodenum. When pumped up with forty to sixty cubic centimetres of air, the balloon occludes the lumen of the duodenum and allows an opaque solution to be injected into that portion of the gut just proximal to it through the other tube which runs parallel to the first tube (in a double-barreled fashion) and empties a few inches proximal to the occluding balloon. (Fig. 1.)

At the conclusion of the procedure the balloon is simply deflated and the whole apparatus withdrawn.

This tube was successfully passed on the patient, it entered the duodenum without difficulty and its tip was observed in the proximal portion of the jejunum about twelve hours later. The following observations are recorded by Doctors Dujat and H. E. Illick:

The tube is pulled back so that the occluding bulb can be inflated at the lower end of the descending duodenum. The inflation was done and easily visualized under direct fluoroscopy and forty-five cubic centimetres of air were injected before the patient complained of a slight pain in the epigastrium. An aqueous suspension of barium sulphate is then slowly injected just proximal to the occluding bulb. About 100 cubic centimetres is seen under the fluoroscope to fill out the first and second portions of the duodenum but none appears to enter the common bile-duct. As soon as an attempt is made to inject a little more barium sulphate solution, the irritable duodenum suddenly expels the whole mass of barium and occluding bulb into the jejunum about eight inches distal to the duodenojejunal junction. The process is repeated, using about fifty-five cubic centimetres of air, and now the irritable duodenum cannot eject the occluding bulb. Injection of 100 cubic centimetres of barium sulphate is seen to start to fill the descending duodenum and then with remarkable suddenness it is shot back into the stomach and is seen at the lower part of the greater curvature and some is seen even up as high as the cardiac end. The duodenal cap alone is seen to retain a fairly well filled-out appearance. None is seen to enter the common duct which was found so dilated at operation about a month

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ago. It is deemed inadvisable to attempt any more forceful measures to fill the dilated bile-duct and the tube is withdrawn, tested, and found to be functioning as well as when passed.

From these observations it did not seem likely that the patient would have any trouble in the future due to regurgitation. His convalescence was entirely uneventful and he was discharged, cured, five weeks after operation. There have been no symptoms suggestive of gall-bladder or pancreatic disease since then.

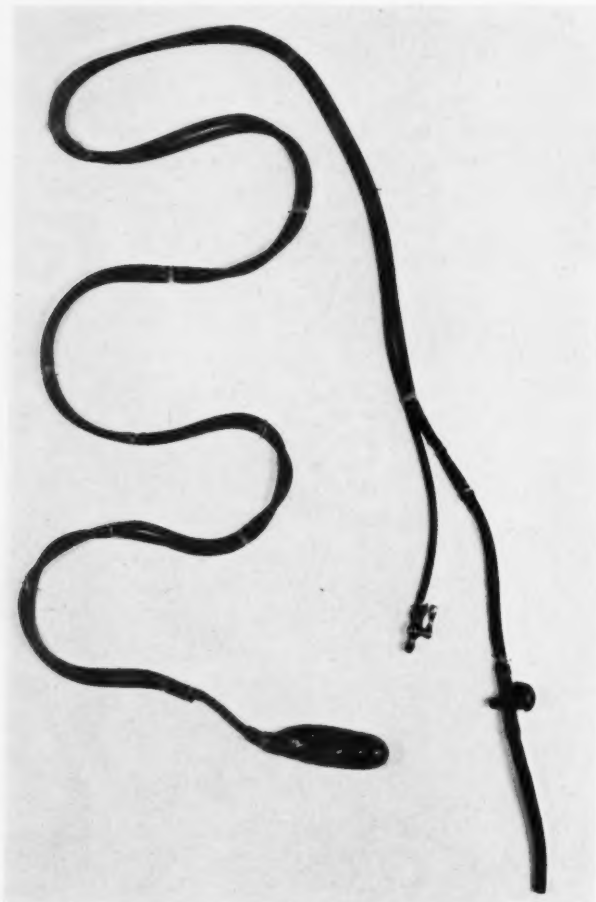


FIG. 1.—Double duodenal tube used for obstructing duodenum and attempting regurgitation into the common duct.

Final diagnosis.—Dilated common duct with obstructive symptoms probably due to chronic pancreatitis.

DR. ALLEN O. WHIPPLE stated that there was a definite group of cases developing jaundice a considerable period after a cholecystectomy in which chronic pancreatitis as an obstructive agent was a definite finding. This group of cases has to be differentiated from those caused by trauma to the duct, or by failure to remove a common duct stone or a recurrent stone. At the Presbyterian Hospital there have been some five cases in which the jaundice, appearing two or more years after a cholecystectomy, was found to

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be due to a chronic pancreatitis. In two of these an anastomosis of the common duct and stomach was done, with relief of jaundice. In the other cases the common duct was drained over a long period of time.

The duodenal intubation for the study of pancreatic ferments and of bile and crystals in the duodenal contents may prove of definite help in differentiating the cases of common duct stone and pancreatic disease. In Doctor Whipple's opinion Doctor Eggers' patient gave a history of previous attacks of subacute pancreatitis resulting in a thickening of the pancreas as found at operation.

DOCTOR EGGERS rejoined that he was not convinced what the actual mechanics underlying the symptoms are. In the case presented there were extensive adhesions, a very much dilated common duct, and a chronic pancreatitis. In spite of these findings, however, no mechanical obstruction could be demonstrated. At the time of operation the common duct was patent. The adhesions apparently played no rôle in the symptoms, a stone or a tumor was not found, and the conclusion is forced on one that the pancreatitis in some way was responsible for the symptoms. It is possible that the degree of obstruction of the common duct varies with the degree of swelling and oedema of the pancreatic tissue. It is also possible that no complete obstruction of the duct is necessary to produce dilatation and sufficient backing-up of bile into the liver to produce jaundice. When one considers that the wall of the common duct is thin and contains only a few muscle fibres, it is conceivable that it may dilate easily and by this very dilatation favor a certain degree of stagnation within it, and that this stagnation in turn, aggravated by a moderate degree of pancreatitis, produces backing-up of bile into the liver. In cases with infected bile the production of jaundice may be explained on the theory of the infection spreading up into the liver and producing a certain amount of hepatitis. In the case presented, however, the bile was sterile both at the time of the first and second operations. Here, no doubt, the mechanical factors were the more important.

Doctor Eggers reported another similar case which is at present under his care. A woman of seventy-one years of age was first seen by him in March, 1932, when he operated on her for acute perforated cholecystitis. Several hundred small gall-stones were removed and a subphrenic abscess, the culture of which showed *Bacillus coli communis*, was drained. On account of the extensive infection the gall-bladder was not removed, but drained. The patient recovered and remained well for about a year. Recently she again had several attacks of severe right upper abdominal pain with vomiting, fever, and jaundice. Röntgen-ray examination was negative. A diagnosis of obstructive jaundice was made, probably due to a common duct stone. On account of the former perforation many adhesions and great technical difficulty had been anticipated, but only light adhesions were found. All organs of the region were easily exposed. The gall-bladder was small, thick-walled, and did not contain stones. It was aspirated and clear bile

obtained, indicating normal function. The common duct was enormously distended to about the size of the duodenum. No stones were felt within it, even after aspirating its contents of thin, clear bile, but a hard, nodular tumor could be felt which at first impressed as a tumor of the papilla, but was later identified as pancreas. A diagnosis of probable carcinoma was made. A cholecystgastrostomy or choledochogastrostomy was technically feasible but under existing conditions threatened to produce too much tension with subsequent leakage and was therefore not done. On account of slight leakage from the puncture holes in the gall-bladder and common duct a cigarette drain was inserted and the abdomen then closed. The culture of both specimens of bile showed colon bacilli. In spite of that the convalescence was uneventful, the jaundice cleared up completely, and the patient has been discharged cured. The clinical diagnosis had to be changed from carcinoma of the pancreas to chronic pancreatitis.

CHRONIC EMPYEMA WITH COMPLETE COLLAPSE OF THE LUNG

DOCTOR EGGERS presented a boy, sixteen years of age, who was first seen by him October 15, 1931, in consultation with the attending surgeon. The boy had contracted influenza the last week of January, 1931, complicated by pneumonia on the right side. After a very severe illness of two weeks, with high fever and delirium, the temperature had come down slowly but never quite reached normal and then began to rise again. Empyema was diagnosed and a rib resection done twenty-six days after the onset of pneumonia. An enormous quantity of pus is said to have been evacuated. The first X-ray examination after operation showed complete collapse of the lung. (Fig. 2.) Drainage from the chest continued profuse, but the general condition improved slowly. He gained weight and was discharged from the hospital about two months after operation with a draining sinus. His surgeon had tried everything within his means to bring about reexpansion of the lung and obliteration of the cavity, and when nothing succeeded he had allowed the wound to close in the hope that reexpansion would be favored by a closed rather than an open empyema cavity. The accumulating pus he had removed by frequently repeated aspirations. Under this treatment the patient had gained weight, from a low 90 pounds, to 142 pounds, and a certain amount of reexpansion of the lung had taken place. When seen by Doctor Eggers about eight months after operation the chest condition was stationary. His general condition was quite good. The right chest showed the following changes: Anteriorly there was flatness with very limited respiratory excursions. Posteriorly there was a healed scar over the ninth rib in the posterior axillary line from the empyema operation and numerous scars from subsequent punctures. There was flatness below with absent fremitus and diminished breath sounds. Above breath sounds were heard anteriorly and posteriorly especially toward the mid-line. No splashing sound was heard. The right shoulder drooped slightly and there was a tendency to deviation of the spine. There was no clubbing of the fingers. The abdomen was negative except for a liver palpable one finger below the costal margin. X-ray examination showed a pyopneumothorax with the lung expanded about 50 per cent. The problem was presented of dealing with the constantly accumulating pus and of bringing about reexpansion of the lung. Establishment of open drainage was advised to prevent absorption of pus and the formation of a thick disabling pleura over a partially collapsed lung. It was felt that con-

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tinuation of the treatment then in use would surely lead to chronicity and require a radical operation later.

This opinion was not looked upon favorably. The family was very reluctant to have any operation performed. It was therefore decided to continue more conservative measures for a while. In turn his attending surgeon used frequently repeated aspiration, closed catheter drainage with suction, and the use of James bottles and exercises. When everything failed he resected a portion of the eighth and ninth ribs together with the underlying thickened parietal pleura and established open drainage. There was improvement in the general condition, but the chronic empyema remained stationary. The right chest was flat and did not expand at all. There had never been evidence of a bronchial fistula. The heart was not displaced.

A radical operation was finally decided on. The cavity was quite clean, as the drainage opening was at its dependent part, just above the diaphragm. There was no fever. The blood count showed 5,370,000 red blood cells, 90

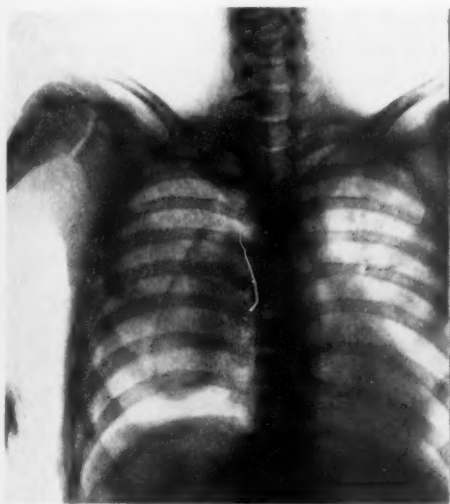


FIG. 2.—Complete collapse of lung after operation for acute empyema.

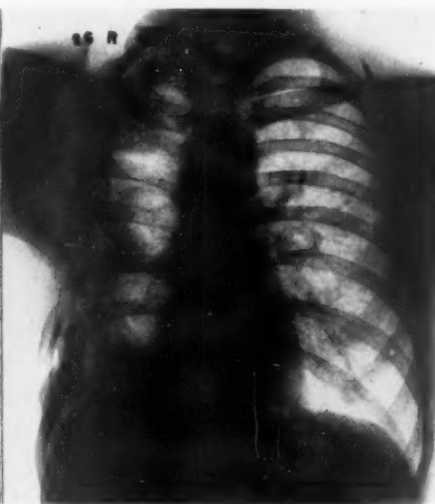


FIG. 3.—Final result after partial reexpansion and radical operation.

per cent. haemoglobin, 11,950 white blood cells, 71 per cent. polymorphonuclears, 28 per cent. leucocytes, 1 per cent. eosinophiles. Culture of the secretion from the wound showed *Bacillus alkaligenes*, while the smear showed Gram-negative bacilli, staphylococci, and short chain streptococci. The urine showed a trace of albumen.

The operation was performed twenty months after his original rib resection. It was done in two stages with an interval of four weeks. At the first operation a portion of the eighth, seventh, sixth, fifth, fourth and third ribs were resected together with the thickened parietal pleura. This completely exposed the cavity. A narrow sinus was found to extend upward from the apex of the cavity for a distance of an inch. There was another narrow recess extending along the costophrenic sinus both anteriorly and posteriorly. The granulations lining these recesses were removed with a spoon. An attempt was then made to decorticate completely the exposed lung but this was not possible. The visceral pleura was very closely adherent to it and apparently there were fibrous tissue bands extending down into the lung substance. Criss-cross incisions were therefore made over the visceral pleura

but no expansion resulted, even on straining. The lung tissue had apparently been damaged by the long collapse and fibrous tissue changes had taken place within it. One more attempt was made to favor reëxpansion by completely mobilizing the lung, but that also failed. To avoid shock the operation was terminated at this point. Drainage tubes and tampons were inserted and the muscles and skin closed around them. The tampons were removed a few days later and the patient was encouraged to practice respiratory and arm exercises and to use James bottles. No improvement resulted and it became evident that a complete thoracoplasty would have to be done in order to bring the chest wall down to the partially expanded lung.

The second stage consisted of the removal of a portion of the first and second ribs, as well as additional pieces of the formerly resected third, fourth, and fifth ribs. In the lower chest a portion of the tenth rib was removed as well as the re-formed ninth rib. There was considerable shock following this procedure, but after that had been overcome the convalescence was quite smooth and the patient was discharged with a narrow sinus, December 24, 1932.

His condition has been very good since then. The sinus has healed, he has no abnormal symptoms and is able to carry on satisfactorily. To prevent increase in the deformity which was beginning to manifest itself when first seen by Doctor Eggers, he has been encouraged to breathe deeply and to practice setting-up exercises. He wears a brace, the use of which is to be continued during his adolescent years. (Fig. 3.)

This case is presented to call attention to the difficulties which are encountered in these patients with a completely collapsed lung. Fortunately these cases are rarely seen. A complete collapse, as shown in this case, must be due to positive pressure on the outside of a lung without the presence of any intrapleural adhesions. Clinically there seem to be but two causes for this, either an open pneumothorax, or perforation of a suppurative intrapulmonary focus into the pleura, with an associated bronchial fistula. The result is complete collapse of the lung, which is quite different from the condition found in the usual empyema. During the development of an ordinary empyema the lung does not collapse; it is compressed to the degree necessitated by the amount of fluid present. Usually adhesions form to surround the fluid and attach the lung to the chest wall. As soon as pus is evacuated there is a tendency for the lung to reëxpand and assume its normal position in the thorax. This is the process observed during the healing of the great majority of empyema cases.

It is only when the fluid forms so rapidly and in such great quantity that no adhesions have a chance to form, that there is danger of a lung collapse on opening the chest. It is for this reason that delay in operating acute cases, and aspiration and closed methods of drainage are advocated.

If an acute collapse in the presence of an open chest has occurred, it is very difficult to bring about reëxpansion, unless one establishes very early negative pressure within the chest by means of a system of drainage bottles. Later on the pleura becomes thickened, changes take place within the lung and the most one can hope for is partial reëxpansion. Nature will do a great deal to obliterate the large cavity by drawing the mediastinum over into the

SOLITARY BONE CYST

affected side, by collapsing the chest wall and by drawing up the diaphragm. Unfortunately, however, this is usually not enough and it becomes necessary to collapse the chest wall sufficiently to meet the partially expanded lung, as was done in this case.

DR. JOHN F. CONNORS referred to two cases of chronic empyema with complete collapse of the lung which he illustrated with lantern slides. The first case was a young woman, twenty-four years of age, who was admitted to the hospital with an *empyema necessitatis*. This was in 1929 and at that time treatment consisted in freeing all adhesions found in the pleural cavity. This case was treated by the packing method. Ultimate cure was obtained in four months. The X-ray showed the collapse of the lung which was almost complete. A second X-ray showed the lung expanded to the chest wall, and there was plain evidence of a collapse of the chest wall, a thoracoplasty done by nature. The second case, a stab wound of the chest, developed pyopneumothorax which was drained by a tube. The X-ray, taken one month later, showed complete collapse of the lung which was plastered to the spine. The patient was readmitted to the hospital for a decortication and with the belief that packing would help to clean the surface of the lung this was done. It was allowed to remain for five days. Astonishing as it may seem, when the packing was removed the lung surface was clean and the lung began to move. There were no further packings and the last X-ray taken showed a complete cure at the end of three months.

SOLITARY BONE CYST—THE LOCALIZED FORM OF OSTEITIS FIBROSA CYSTICA

DR. BRADLEY L. COLEY read a paper with the above title for which see page 432.

DR. NORMAN L. HIGINBOTHAM (by invitation) said there were one or two points in this study which should be emphasized: One, that osteitis fibrosa cystica is a multiple lesion, but the paper deals with a single lesion. In all the cases in this series of twenty-six the blood calcium determination was normal. When a lesion such as was shown in the slides is present they believed it worth while to take skeletal X-rays to determine the presence of bone lesions in other parts of the body. In the twenty-six cases treated by different surgeons it is obvious that they had different methods of treatment. The choice, however, is the surgical treatment Doctor Coley mentioned, that is, thorough curettage of the bone cavity and primary wound closure. Most of these cases occur before the age of twenty. Therefore irradiation is contraindicated because it inhibits epiphyseal growth and union.

DR. FREDERIC W. BANCROFT called attention to the point that Doctor Coley had brought out relative to the definite anatomical distribution of the lesion. A study of the distribution of the nutrient artery in children showed that the terminal branches of the nutrient artery supplied the metaphysis and that there is a very poor anastomosis with the epiphyseal vessels. One might assume, therefore, that this is some type of vascular occlusion of the terminal branches of the nutrient artery, associated with decalcification. While it is true these lesions heal after fracture, recurring fractures are far

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too common. The treatment, therefore, should be aimed toward preventing fracture and to create some means of increased calcification within the cyst.

Doctor Bancroft took issue with Doctor Coley on the question of straight curettage, because he believes that something should be added that would stimulate osteogenesis. He showed slides of two cases, one in which a bone transplant from the fibula had been introduced and another one where small bone chips had been introduced. Late follow-up pictures showed osteogenic repair.

It had seemed to Doctor Bancroft that frequently a Brodie's abscess and osteitis cystica fibrosa were wrongly diagnosed on radiological evidence.

DOCTOR COLEY emphasized his belief that conservative surgery is the best form of treatment and, as experience with this work has grown, he feels less content with the permanence of the repair which takes place spontaneously following a pathological fracture. Curettage, with or without the use of bone chips, seems to give the most satisfactory and lasting results.

BRIEF COMMUNICATIONS

FRACTURE OF THE HYOID BONE

THE following case of fracture of the hyoid bone is reported because this lesion is comparatively rare. It occurred several hours after an operation on a distant part of the body without any definitely known cause. Apparently this is the only recorded case complicated by a subcutaneous emphysema.

CASE I.—A muscular and very powerfully built man, twenty-one years old, sustained an injury to the external semilunar cartilage of his left knee while in a football scrimmage. This joint was subjected to operation for removal of the damaged meniscus December 23, 1932. The operation and the anaesthesia were uneventful. At no time during the induction of the narcosis or the operation was there any struggling or unusual muscular activity. After the operation nothing unusual was observed.

In the afternoon of the day of operation, which was performed at eight in the morning, the patient complained of a sore throat and pain in the chest. An examination of the chest was negative; the discomfort in the throat was assumed to be an irritation from the anaesthetic, which was gas-oxygen-ether. On the following morning the patient, who was a quiet, stolid individual, complained of a severe sore throat. He had difficulty in opening his mouth. Articulation was painful and he spoke in a whisper. He had spat up some blood. His neck and chest were swollen from a subcutaneous emphysema, extending down to the nipple line and up on both sides of the neck to the angles of the lower jaw. A more careful investigation revealed a congested, swollen, beefy pharynx, with marked redness and oedema of the uvula and soft palate. There were several ulcerations on the uvula. There was marked tenderness in the upper part of the neck. Laryngoscopic examination was difficult but showed no gross lesion of the cords or surrounding structures. The patient spoke only in a loud whisper, stating that he thought he could speak louder but for the pain. Swallowing was painful.

It was assumed that the metal tongue depressor used during the anaesthetic had damaged in some way the mucous membrane of the mouth, although the anaesthetist insisted that at no time was there any occasion for rapid or violent insertion of this instrument. On the following day all the symptoms persisted. An X-ray picture was made of the neck which revealed a fracture of the hyoid bone at the junction of the body with the greater cornua. (Fig. 1.) The discovery of this lesion explained all the symptoms. The fragments of the hyoid bone had evidently perforated the mucous membrane of the floor of the mouth, with resultant entry of air into the subcutaneous and fascial planes, causing the emphysema, and the extreme congestion of the soft palate, pharynx and larynx. More careful palpation of the neck revealed tenderness to pressure limited to the body of the hyoid bone. There was no crepitus.

The symptoms continued for about a week and then rapidly subsided. When discharged from the hospital a little over two weeks after the operation the patient was comfortable. The swelling of the neck and chest had disappeared. There was no dysphagia or soreness of the throat, and speech was normal.

An X-ray of the hyoid bone made at that time showed the body and cornua to be in practically normal relation. The wide gap seen in the original film has been greatly reduced, although no manipulative reduction had been attempted.

A review of the literature on this subject reveals the fact that in every case there was a known injury, leaving no doubt about the mechanism of production of the fracture. There are three well-established causes for fracture of the hyoid bone: (1) Direct injury as in strangulation, run-over

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accidents, or a direct blow on the side of the neck. (2) Indirect violence as a sudden hyperextension or flexion of the neck in a fall. (3) Muscular violence as in forcible swallowing. In my case it must be assumed that the cause was an abnormally severe contraction of the neck and throat muscles. Direct violence is out of the question, and even indirect violence through post-operative restlessness may be ruled out, as this patient was under continuous observation and had been unusually quiet. Additional confidence



FIG. 1.—Lateral roentgenogram of neck showing bilateral fracture of the body of the hyoid bone with separation of the body from the greater cornua.

may be placed in the muscular theory as this patient is of a very powerful build with very strongly developed muscles all over his body, and also in the neck.

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PATELLA BIPARTA

THIS X-ray picture (Fig. 1) illustrates a rather unusual type of what is called *patella biparta*, indicating two centres of ossification. The chief interest in the anomaly is that if discovered after an injury to the knee in an adolescent, it may be mistaken for a fracture. From this it may be distin-

PATELLA BIPARTA

guished by the smooth outlines and symmetrical relation of the two segments, as in this instance.

A more common and more important form is what is sometimes called fragmentation, when there are several small ossifying centres, usually near the outer and upper border of the patella. This condition is usually discovered in investigating the causes of discomfort or disability at the knee, and it may be mistaken for a new growth. In rare instances it may be the cause of symptoms, either by actual irritation—"osteochondritis"—or irregularity in development that may induce friction. Occasionally the fragmentation may be at the lower border of the patella and may be mistaken for a floating body, or the patella may be divided into two fairly equal parts, lying side by side or one superimposed on the other.



FIG. 1.—The anomaly described is on the right side and on the internal border of the patella. A similar condition is to be seen on the left side, an important point in diagnosis.

In the second class of cases operative removal may be indicated, but in most instances it is an accompaniment rather than a cause of the symptoms. A very important point in the diagnosis is that the anomaly is usually bilateral as in this instance. Thus in doubtful cases an X-ray picture of the sound knee should always be made.

According to Dueño, the most recent writer on the subject, who has investigated eighty cases recorded in literature, 75 per cent. were fragmentation in the situation described, 20 per cent. below the patella, and but 5 per cent. of the lateral type were presented. (Rev. de Cirug. de Barcelona, vol. 2, p. 137, 1932.)

ROYAL WHITMAN, M.D.

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AVERTIN IN THE PAIN CRISES OF BLOOD-VESSEL SPASM

PERHAPS the most difficult and trying feature connected with blood-vessel disorders of the extremities is the break in morale that frequently comes as a result of the prolonged suffering most patients are compelled to endure. Operative attack on the sympathetic nervous system and nerve injection or nerve section are of certain usefulness in providing relief, but only too often the battle is lost before ever the patient comes in and prompt amputation offers the only hope of salvation. Occasionally, too, more especially in instances of multiple extremity involvement, the situation is so serious and so tragic that one is at his wits' end to know just where to begin or what to do. Such a case presented itself to us recently and after much trial and tribulation we solved it in such an unusual manner—by the continued use of avertin—that we felt an early report would be in order that others might have the advantage of what would seem to be a comparatively harmless but very effective method of procedure. We know avertin has been used similarly in other maladies,¹ but so far as it has been possible for us to determine it has not been employed in blood-vessel conditions.

The case is as follows: L. S., male, aged thirty-two, was operated on by Dr. Harvey B. Stone, of Baltimore, April 1, 1930, for pain and threatened gangrene of the right foot. Doctor Stone did a peri-arterial sympathectomy on the right femoral artery, following which, with the exception of losing the distal half of one toe, the patient made a complete recovery. Thus far he has had no further pain or discomfort in that leg and has been able to walk on it without difficulty.

In the early spring of 1933 he began to have pain in the first and second fingers of his right hand and later on, some one having accidentally stepped on his left foot, an ulcer developed under the big toe at its base. In spite of the warning he had had in 1930, at which time a diagnosis of Raynaud's disease was made, patient did not seek medical advice until early in August (1933). We did not see him until a month later, at which time his condition was so serious that he was sent at once into the Union Memorial Hospital. At that time there was a rather deep excavated ulcer just under the proximal joint of the left big toe, which looked ominously blue. He was not, however, having any pain in this toe or foot. He was having most of his pain in the first and second fingers of the right hand. The distal end of the first finger was already gangrenous, while the tip of the second finger was threatened with gangrene. The patient's right foot and his left hand were quite all right as regards pain, although the left hand was at times rather uncomfortable. By the time we saw him the patient had been having so much pain and so much suffering that his physician had been compelled to give him all kinds of sedatives, other than morphine, but they had given little or no relief and his nerves were obviously badly shattered. He had lost much sleep, he was thin, very pale, perspired very freely, and was much concerned about his condition. Like most other patients of this character he was a great cigarette smoker.²

On examination at the Union Memorial Hospital we found that his general condition was fair but that the blood-vessels of his extremities were sadly blocked. No pulse in either leg could be felt below the femoral at the groin, and neither radial pulse could be obtained. The ulnar artery could be felt pulsating at the left wrist and both brachials could be felt at the elbow but there was a very definite diminution of the blood supply to both hands. We rather felt that a peri-arterial sympathectomy on the right brachial artery was indicated and the patient was quite willing to have it done, but he was so nervous and upset that it was thought best to try to carry him along for a few days to see what could be accomplished conservatively.

AVERTIN IN BLOOD-VESSEL PAIN

It was impossible, though, to give him any rest. We used repeated doses of codeine, luminal, sodium amytal, together with other similar sedatives, but he just could not sleep or even rest. He had a peculiar twitching even when he was drowsy and at the slightest provocation would break out into a profuse sweat. A few days (by B. M. B.) on September 6, 1933—at his own insistence, a peri-arterial sympathectomy was done on his right brachial artery, local anæsthetic, novocaine, being used. On the very next day patient developed a violent generalized urticaria, but small doses of adrenalin cleared it up in twenty-four hours.

Following this, the patient had definitely less pain in the affected hand and arm, but he still was absolutely unable to rest. He twitched and he tossed and complained constantly. His left foot began to pain him and then his left hand (the unoperated one) became more uncomfortable. The pain was not so terribly acute anywhere but little things annoyed him enormously. We tried giving him large doses of sodium amytal and then larger doses of codeine, together with the various sleep-producing drugs, but nothing helped. It was only when we gave him morphia that he got any rest at all, and this was fleeting. It seemed as if the man would go insane or pass out from sheer exhaustion unless something could be done, so in the emergency we decided to put him to sleep with avertin and keep him there for a period of days, if necessary.

The first dose was given to him September 9 at 9 P.M., the dosage being seventy milligrams per kilo. This was rather small and we rather felt that it would take much larger doses to achieve profound narcosis, but the man's physical and mental condition left so much to be desired that we decided to proceed slowly and cautiously—even though permission had been granted us by the family to use any and all means to give rest. The blood-pressure, which had been 125/90 on admission, but was only 108/70 at the moment, dropped to 106/66 and patient became very restless and pretty much unmanageable in spite of the fact that he was not conscious. This lasted three hours, at the end of which time it was thought best to give Schlessinger's solution, minims 10, by hypodermic, which supplemented the waning action of the avertin. At 5 A.M. he waked up but remembered nothing after the instillation of avertin. Unsatisfactory though this first trial was, it was the best night since he had entered the hospital.

Averse to giving him more avertin at the moment because he seemed so weak, we carried him through the day on the usual sedatives as best we could. At 9 P.M. the following night (September 10), he was given eighty-five milligrams per kilo of avertin. His blood-pressure, which had in the meantime resumed its normal level, remained steady at 124/68. He rested quietly until 11:30 P.M., that is, two and a half hours. When he waked up he was given thirty milligrams per kilo more of avertin. His blood-pressure remained the same and this produced rest until 3 A.M., at which time he was given morphine sulphate, grains $\frac{1}{4}$, by mouth. He then went through the rest of the night satisfactorily and during the next day seemed somewhat quieter.

On September 11, at 10:15 P.M., he was again given eighty-five milligrams per kilo of avertin, but this carried him for only one and a half hours. So at 1:20 A.M. he was given forty milligrams more, following which he became restless and unmanageable. His blood-pressure remained at 127/80. At 3 A.M. he was given $\frac{1}{4}$ grain morphine orally and rested fairly well. The following morning he stated that he slept well during the night but he did not feel that it was a natural sleep. *Patient had a fairly comfortable day following this and did not need any sedatives to speak of.* On the night of September 12 he was given ninety milligrams per kilo of avertin at 10:30 P.M. At 11 P.M. his respirations were somewhat shallow but became normal within thirty minutes. His blood-pressure was 120/78. He slept then for three hours, after which he was given $\frac{1}{6}$ grain of morphine sulphate, followed forty-five minutes later by $\frac{1}{4}$ grain, both by mouth. We hated to give him this morphia, but each time he came out of the avertin he fussed about so much that it had to be given in order to keep him quiet.

The next day—September 13—patient seemed somewhat drowsy but he was awake most of the time and was able to take his food. He seemed less nervous and required

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but little sedatives. We were anxious to get him off the avertin so on the night of the 13th it was decided not to give him any but to give him sodium amytal instead. At 9 P.M., therefore, he was given three grains of sodium amytal by mouth but it did not help, so at 11 P.M. he was given three more grains. This did not help him either, so at 1 A.M. and again at 4 A.M. he was given $\frac{1}{4}$ grain morphine orally. *He kept asking for avertin all night long.* Next day—September 14—we did not think he was quite so well, so we decided to give him avertin again. The dose was eighty-five milligrams and was given at 9:30 P.M. His blood-pressure dropped to 110/70 and his respirations were slightly more shallow than normal for thirty minutes, but were perfectly all right after that. At 1 A.M., when he seemed on the verge of waking up, he was given thirty milligrams more of avertin. His blood-pressure then dropped to 105/70, but he seemed in good shape and rested well until 5 A.M. He had no morphine.

Briefly, patient had avertin as follows:

Sept. 9 at 9 P.M.....	70 milligrams	} 115 in the one night
Sept. 10 at 9 P.M.....	85 milligrams	
Sept. 10 at 11:30 P.M.....	30 milligrams	
Sept. 11 at 10:15 P.M.....	85 milligrams	} 125 in the one night
Sept. 12 at 1:20 A.M.....	40 milligrams	
Sept. 12 at 10:30 P.M.....	90 milligrams	
Sept. 13.....	None	
Sept. 14 at 9:30 P.M.....	85 milligrams	} 115 in the one night
Sept. 15 at 1 A.M.....	30 milligrams	

Total amount given, 515 milligrams per kilo over a period of 6 nights 36.05 Gm.

On the following day—September 15—patient seemed distinctly better and was much less nervous and needed little or no sedatives. That night, then, instead of avertin, we gave him $3\frac{3}{4}$ grains of sodium amytal intravenously at 9:40 P.M., and at 11:30 P.M. he was given three grains of sodium amytal orally. Fifteen minutes later he got three more grains of it orally. He had some rest but did not sleep very well. By this time, though, his general condition was distinctly improved and his mental attitude had changed so that it seemed possible to bring him out of his slump. We thereupon put him on small doses of whiskey,* given every three hours, in the effort to make him drowsy. By this means it was possible to carry him along both by day and by night without much more difficulty and gradually the intervals between the doses of whiskey were lessened, while the sedatives needed were practically nil.

Following the above episode patient received an occasional dose of luminal and once in a while a little whiskey, but it was not necessary to give him any more avertin and he was completely off the morphine. His mental condition improved very much, he became much less fidgety and did not break out in the profuse sweats as formerly. His appetite became better and he went through his nights fairly well. The pain in both hands eased and the gangrenous processes of the first and second fingers of his right hand stopped at the second joint and the first joint respectively. The parts affected mummified and were later on removed. It is sad to relate, though, that the gangrenous process of his left big toe gradually, though rather painlessly, involved first the adjacent toes and then the whole foot to such extent that the leg had to be removed. (It will be noted that this is the leg that had no peri-arterial sympathectomy.) Patient went through this ordeal under avertin and gas anaesthesia quite satisfactorily and made a prompt recovery.

It was natural that concern should be had lest the successive doses of avertin have some deleterious effect but nothing of the sort was noted in the blood, the kidneys, or the liver, functional tests of the two latter being entirely normal. It was interesting, too, to note that during each day following the administration of avertin the patient was somewhat drowsy but could be roused without difficulty. Furthermore, and best of all, his appetite seemed unaffected. Indeed, as he became quieter his appetite picked up.

* Whiskey had been tried before the avertin but had not helped.

SIMPLE GLASS BLOOD TRANSFUSION APPARATUS

To sum up, then, we present the case of a young man whose morale, as the result of multiple extremity involvement and profound suffering over a long period of time, was so badly shattered that none of the usual methods of relieving his distress and giving him rest was of avail. In the emergency he was given successive doses of avertin over a period of six days and nights—eight doses in all, a total of 515 mg. per Kg. or 36.05 Gm. Upon several occasions he was given two doses, the second smaller than the first, within three or four hours. He gradually became quieter until finally it was possible to switch him over to the more usual means of dealing with such conditions. This patient suffered no harmful effects from the avertin and is now—six months later—well on the road to recovery, after having gone through a second major operation.

Naturally, it is impossible to generalize too much from one case, but the result obtained in this instance was so unexpected and startling as to warrant the hope that maybe a new method has been found to deal with conditions that have hitherto been most intractable and unsatisfactory.

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SIMPLE GLASS BLOOD TRANSFUSION APPARATUS

THERE are numerous apparati for performing blood transfusions. However, the illustrations below present a very simple, inexpensive apparatus already available as an importation from Japan where it is used for other purposes. It consists of a simple Y-shaped glass adapter (Fig. 1) with a ground-in glass valve in each arm making a ball-valve arrangement. The glass valves in each arm of the Y-adapter open and close by suction and pressure respectively as the piston of the syringe is pulled out or pushed in. On the upstroke the action automatically opens the valve from the donor and closes the valve to the recipient and conversely on the downstroke closes the valve from the donor and opens the valve to the recipient. The valve arrangement is airtight and leak-proof so that there is no reflux or possibility of admixtures of blood. The adapter is made of transparent glass so that the entire procedure is constantly visualized. Each extremity is bulbous so that rubber tubing may be fitted over it. Any size Luer syringe may be used with the adapter, but the medium-sized ten-cubic centimetre syringe has been found the easiest to handle.

This apparatus greatly facilitates the giving of blood transfusion without the use of saline. It is desirable during the transfusion to spray ether on the syringe and glass adapter. This delays clotting and prevents the piston of the syringe from sticking. The syringe is preferably changed after the transference of 200 cubic centimetres of blood. The bi-valve glass adapter does not stick

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during a transfusion of 500 cubic centimetres of blood. For larger transfusions it is better to insert a new glass valve apparatus.

The materials and apparatus are prepared for blood transfusion according to the method published by Lewisohn and Rosenthal.¹ This provides for the special cleansing of the apparatus to remove old blood and eliminate foreign protein.

A slight modification of the apparatus (Fig. 2) is particularly valuable for infusion of intravenous solutions, such as 50 cubic centimetres of 50 per cent. glucose, saline, or solutions for local anaesthesia.

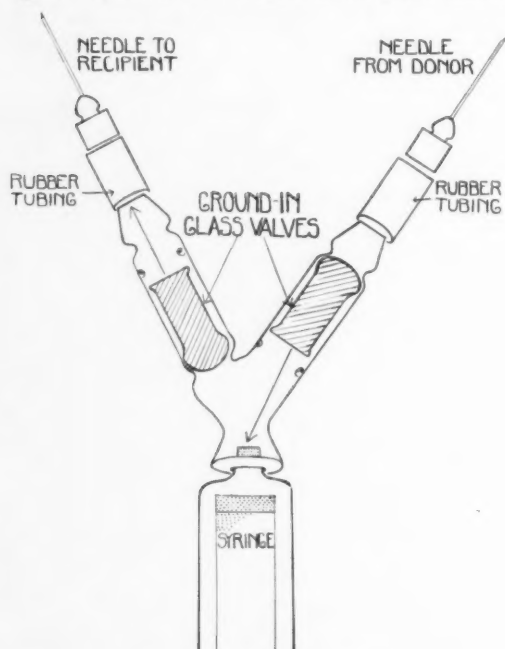


FIG. 1.—Set up for transfusion.

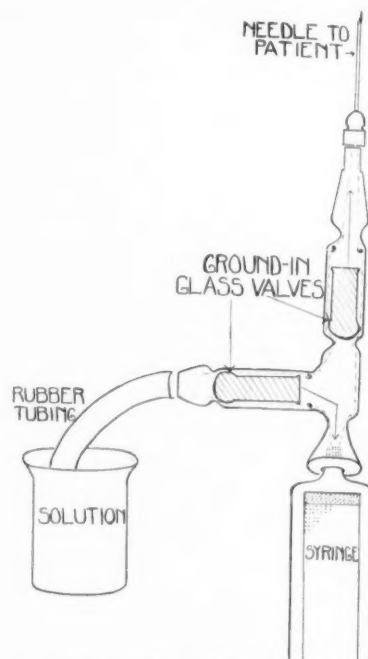


FIG. 2.—Set up for infusion.

A small syringe may be used for this purpose to insure a continuous flow without detaching the syringe to draw up additional solution. A desirable feature is the grounding of one extremity so that a needle may be attached directly to it. This modification is also very desirable for the withdrawal of body fluids, as in a thoracentesis or aspirating a gall-bladder or cyst at the operating table. For this purpose the arrangement of the valves is reversed.

There are several advantages in the use of this universal bi-valve glass adapter: (1) The ease in setting up for transfusion and simplicity in operation due to automatic action. (2) The adaptation for thoracentesis, paracentesis, and infusions. (3) A more or less continuous flow of fluid with any size Luer syringe. (4) The low cost.

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¹ Lewisohn, R., and Rosenthal, N.: Prevention of Chills Following Transfusion of Citrated Blood. *J.A.M.A.*, vol. 100, pp. 466-469, February 18, 1933.

REPEATED EMBOLECTOMIES

EMBOLECTOMY: REPORT OF TWO ATTEMPTS ON THE SAME PATIENT

IN THE ANNALS OF SURGERY of July 1932, the writer reported an unsuccessful embolectomy performed on a woman, aged sixty-four, with an embolus involving the left femoral artery. The present report is intended to show that the operation of embolectomy may fail to cure the patient even when performed soon after the supposed lodging of the embolus.

J. S., male, aged forty-five, carpenter, with negative past history except for a mild diabetes mellitus of eight years' duration, was admitted to the Billings Hospital March 11, 1932, on account of pain in the left arm and cyanotic discoloration of the arm almost up to the elbow of eighteen hours' duration. The onset was sudden with acute pain in the arm and hand, not relieved by massage. Five days before admission the patient had a cough with hæmoptysis and generalized chest pain. Examination revealed cardiac enlargement associated with a diastolic murmur. There was a friction rub in the right posterior pulmonary base. The left arm was markedly discolored to within six centimetres of the elbow and skin temperature and skin sensation tests indicated that this was the point of maximum change. The left leg was a little colder than the right and the dorsalis pedis pulsation was weaker on the left than on the right. The coagulation time was two and one-half minutes and the bleeding time one and one-half minutes.

Two hours after entrance the artery was opened in the axilla under local anaesthesia. By probing upward fifteen centimetres an embolus, two centimetres long, shot forth followed by a gush of blood. The radial pulse did not return nor was there any change in the appearance of the arm so a second arteriotomy was made in the cubital fossa and another clot removed. There was still no change in the appearance of the arm and it was assumed that the operation was done too late and that thromboses filled all the smaller arteries. Complete mummification to the elbow required amputation at the middle of the humerus on March 28. Pathological examination revealed no arterial disease.

On March 18 there was numbness and tingling in the left foot of sudden onset. The foot was blanched and cold; all sensation was lost over the toes and sensation to touch was lost over the sole of the foot. Skin temperature tests showed the point of maximum change to be at mid-calf. Operation was performed two hours later under local anaesthesia. Arteriotomies were made in the popliteal artery and in the posterior tibial artery just above the internal malleolus. Clots were removed from both places, but arterial flow was not restored. The next day the foot was blue and on April 13, the leg was amputated at the junction of the middle and lower thirds of the tibia. The stump became infected and *Bacillus welchii* obtained, but there was no crepitation. The leg was amputated at mid-thigh on April 15 and the next day the patient died with a temperature of 41.6°C. The anatomical diagnosis was thrombosis (both organized and recent) of the circumflex branch of the left coronary artery with extensive infarction and atrophy of the myocardium of the left ventricle; marked fibrous replacement of the myocardium of the left ventricle; parietal thrombus over the infarct in the left ventricle; peripheral arterial thromboses with infarction of the spleen, kidneys and lower lobe of the right lung; healed amputation stump of the left arm; open amputation stump of the left leg.

Histological examination of the kidney infarct indicated that it was at least six months old. The pulmonary infarct was probably the cause of the hæmoptysis. Although the patient never had symptoms in his leg until two hours before the second operation, examination a week before indicated circulatory deficiency. This may have been due to small emboli preceding the final one or to thrombosis, but it is interesting to note that without this oppor-

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tunity to examine the leg a week before the probable circulatory weakness would never have been suspected. None of the arteriotomies were done on vessels not already occluded and as they were all done under local anaesthesia, it is probable that they neither hastened the impending gangrene nor endangered the life of the patient. During the operations it was noticed that the blood clotted faster than normal even though the pre-operative and post-operative coagulation times were normal. It is probable that the coagulation time alone is not the real index of intravascular coagulation tendency as has been shown recently by Bancroft.

Bull¹ found 181 instances of parietal cardiac thrombi in a series of 6,140 necropsies and the present case is an instance of multiple embolism from one of these thrombi. Recent reviews of the subject of embolectomy by Danzis² and by Pearse³ confirm the belief that the majority of emboli lodging in peripheral vessels are cardiac in origin.

The probable endogenous *Bacillus Welchii* infection is of interest. Andrews recently has reviewed the literature on this subject and called attention to the frequent presence of this organism in normal tissues.

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MEMOIRS
ALEXIS VICTOR MOSCHCOWITZ
1865-1933

ALEXIS VICTOR MOSCHCOWITZ came to America from Hungary when a boy of fifteen. Industry and enthusiasm were ever prominent in his per-



ALEXIS VICTOR MOSCHCOWITZ, M.D.

sonality. He was graduated in pharmacy in 1885 and then entered the College of Physicians and Surgeons, Columbia University. On receiving his

ALEXIS VICTOR MOSCHCOWITZ

degree in 1891, he was awarded one of the Harsen Prizes for distinguished scholarship. Later he became Professor of Clinical Surgery to his Alma Mater.

His first post-graduate position was that of interne in the German Hospital of New York, now the Lenox Hill Hospital, where he gained the confidence and friendship of those with whom he worked. After a short period in general practice he became the Associate of the late Doctor Langmann and also of that progressive surgeon, Willy Meyer. In 1895 he secured a place in the out-patient department of Mount Sinai Hospital from which it was but a stepping stone to an appointment as Adjunct under Dr. Arpad G. Gerster. He reached the rank of full Attending Surgeon in 1914.

His originality and faithfulness carried him far toward the high places in his profession. He became Consulting Surgeon in 1927, an office which he held for the remainder of his life. Other institutions sought his professional skill and he became attached to several in the capacity of Attending or as Consultant.

A Fellow of the International Surgical Association, he enjoyed to the full the cordial friendships which he made with surgeons from many countries. In 1927, he was made a Fellow of the Royal Academy of Physicians of Rome. Mrs. Moschcowitz invariably accompanied him to the Congresses and by her gracious and congenial presence added greatly to the pleasure of the social functions.

To enumerate by their title all the notable contributions made by Moschcowitz would far exceed the limits of this memoir. There was scarcely a field to which he did not contribute. His name is especially distinguished as an expert in hernia. A monograph by him on this subject was published in Johnson's Operative Surgery, which has long been considered authoritative.

The final addition to his works was the paper on Vestigial Mastitis, read before the American Surgical Association at the meeting of 1933. It is a piece of scientific, clinical and literary investigation which cannot fail to link his name with the disease which he described.

During the war, Alexis Moschcowitz was appointed by the Surgeon General to the Empyema Commission where he did outstanding service in research as well as in the operating rooms of many of our military hospitals. His abounding patriotism appeared to bring him as much gratification and pride in the title of Colonel in the Army as his many honors in civil life. Soon after the war (on December 12, 1919), Doctor Moschcowitz by invitation of the College of Physicians of Philadelphia delivered the Mütter Lecture before that body.

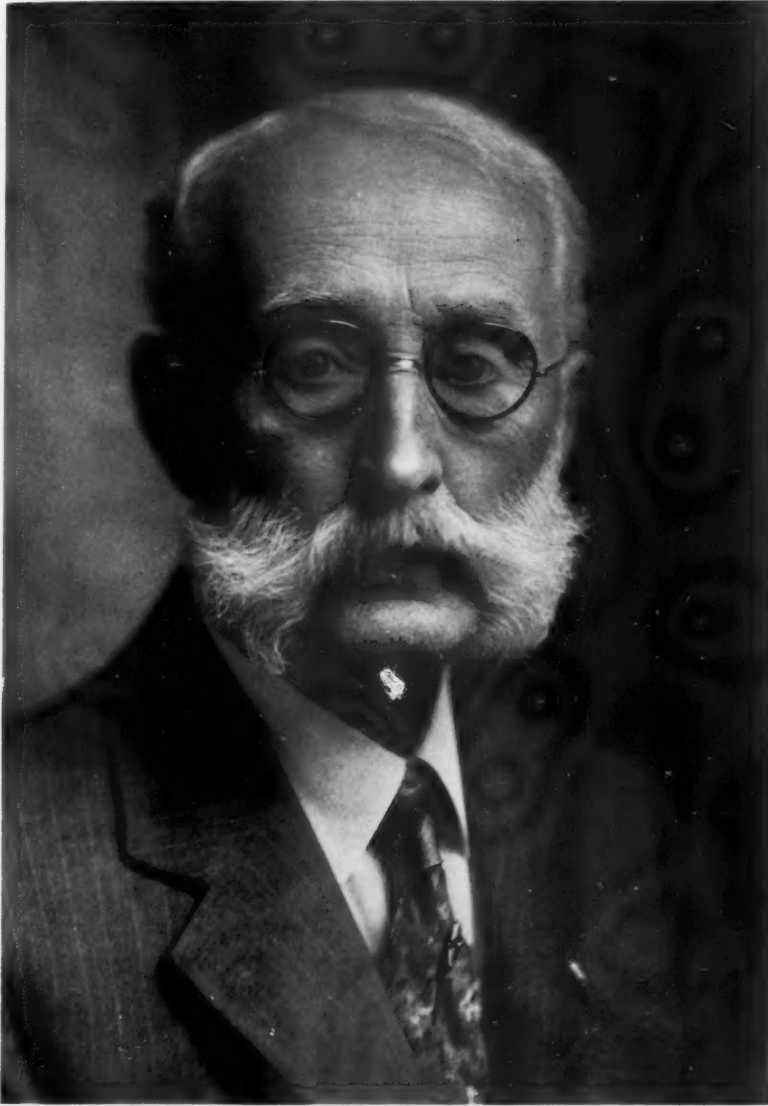
At Mount Sinai Hospital, where I knew him best, he held the affection and respect of everyone—the trustees, his colleagues, the nurses—all who served with him in any capacity. He will always be remembered with affection for his gentle ways, his friendly smile and a certain whimsical humor which made all his companions prepare for something wise and witty whenever he rose to speak.

HOWARD LILIENTHAL, M.D.

MILES FULLER PORTER

1856-1933

MILES FULLER PORTER was born September 27, 1856. His father was a surgeon in the Union Army and the war orphaned him at an early age, making his later education dependent largely on his own exertions. It was these youthful struggles that developed one of his most marked characteris-



MILES FULLER PORTER, M.D.

tics, that of self-reliance. It was not easy for him to change or to admit that he had been mistaken. His early orphanage also bred in him a habit of industry. He was never idle. From early childhood he knew what his vocation would be and every effort was bent toward attaining that goal. He was

MILES FULLER PORTER

graduated from the Ohio Medical College in 1878. He was in love with his profession, and it was this absorbing interest that made him regular in his attendance on medical society meetings, and ready to defend his opinions on any subject on the floor. In debate he was a forceful speaker because he spoke from a wide experience, and had implicit confidence in his own judgment.

He attained membership in all the leading Surgical Associations. He served his county and state organizations as president and became a trustee of the A.M.A. from 1900 to 1909.

The writer's professional association with Doctor Porter dates from 1891, when he was doing a prodigious amount of work in general practice. It was always a matter of surprise that one so frail-looking could endure the loss of so much sleep. Nearly all of his early surgery was recruited from his own patients, but gradually more and more of his surgical cases were referred by other physicians until in 1899 he found it necessary to limit his practice. This gave him more time to devote to study and the preparation of papers for publication. For a number of years he edited the department of surgery in the Fort Wayne Medical Magazine which later became the Journal of the Indiana State Medical Association.

It may truthfully be said of Doctor Porter that he was a self-made man for although he yearned for the opportunity to perfect himself by study abroad in his younger years, the demands of a large and growing family made this impossible. He did manage to see some of the London and Edinburgh hospitals while recuperating from an illness resulting from overwork.

His code of morals was very strict. He gave to his patients the best service of which he was capable without regard to recompense. He was ardent in his condemnation of every act that might be construed as at all dishonest, or not open and above-board.

Doctor Porter's home life was ideal and he could always be found there when not engaged professionally. To those who did not know him well he was often regarded as austere and difficult of approach, whereas the exact opposite was the truth. He was ever ready and willing to make any sacrifice for a friend.

He bore his last, long, painful illness with fortitude and maintained his interest in medicine to the end by contrasting published accounts of his malady with the progress his own case made to a fatal termination on Dec. 6, 1933.

Like Osler, "he was only sorry he could not attend the post-mortem."

BUDD VAN SWERINGEN, M.D.

EDITORIAL ADDRESS

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